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Final Technical Report

# Aquatic Biology

Prepared for

**Bureau of Land Management**

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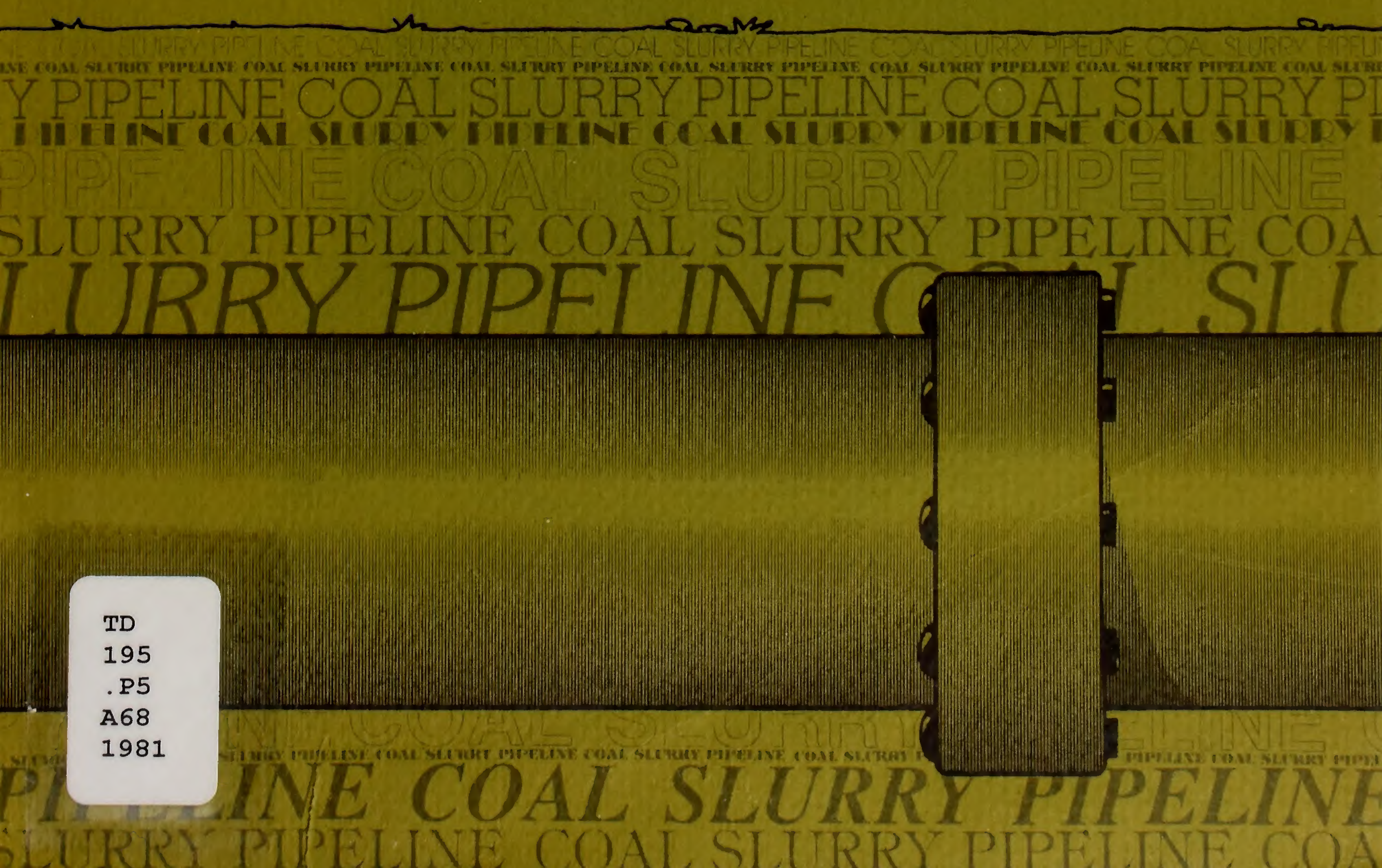
**Woodward-Clyde Consultants**

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# AQUATIC BIOLOGY

# TECHNICAL REPORT

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Chapter 1

# INTRODUCTION

This report, the Aquatic Biology Technical Report, is one of three technical reports that address biological resources that may be affected by the ETSI coal slurry pipeline project. The other two reports addressing biological resources are the Terrestrial Biology Technical Report and the Threatened and Endangered Species Technical Report. The need for these separate documents results from the new CEQ guidelines, which limit the final EIS document to a discussion of pertinent environmental information and associated impacts.

This report is organized into two major sections: Affected Environment and Environmental Consequences.

Tables identifying proposed stream and river construction locations are presented throughout the Affected Environment section. Where in-river construction (e.g., pipeline crossing, barge facility, etc.) would require a Section 10 permit, an individual 404 permit, and/or Natural and Scenic River consideration, the appropriate water body is designated by a numerical superscript identifying the permits required.

In all phases of aquatic impact analysis, emphasis will be placed on fishes, macroinvertebrates, and sensitive classification species. Other components of the freshwater community including phytoplankton, zooplankton, periphyton, and vascular plants will be considered only in the few situations where anticipated impacts could significantly affect their populations. The high and rapid reproductive potential of plankton and periphyton populations should make them resistant to both short- and

long-term construction and operation impacts. Vascular plants may be affected by direct removal from riverbeds due to construction of the pipeline but it is anticipated that, generally, these impacts will not be significant on a population level.

In order to judge the biological severity of anticipated impacts, it is imperative to define the terminology of impact assessment for this project. Short-term (or temporary) impacts are considered to be biological disturbances which are anticipated to be detectable for a period of five years or less. Long-term biological impacts must be anticipated to be detectable for more than five years. Intermittent impacts are considered to be short-term, recurring biological disturbances.

Impacts will be considered to be localized when they are anticipated to be confined to the physically disturbed stream crossing right-of-way and the downstream area where disturbed sediments or other materials are carried by natural currents. Aquatic biological impacts will be considered "extensive" when they affect the biota or habitats of a larger area than defined above.

Impacts will be considered insignificant when they are anticipated to kill or displace few (if any) fishes or macroinvertebrates, which are not considered to be sensitive classification species, as a direct or indirect result of project construction or operation. Impacts will be considered significant when they are anticipated to kill or displace numerous fishes or macroinvertebrates (whether or not they are sensitive classification species) as a direct or indirect result of project construction or operation. Impacts will be considered severe when they are anticipated to kill or permanently displace populations of fishes or macroinvertebrates as a direct or indirect result of project construction or operation.

In the assessment of impact an attempt will be made, where possible, to estimate the period of time required for habitat and population recovery from the identified impacts.

All biological data upon which impacts are assessed in this document were collected from state and federal resource agencies, technical libraries and literature, and regional authorities prior to July 1980.

Chapter 2

AFFECTED ENVIRONMENT

## 2.A PROPOSED ACTION

### 2.A.1 COAL SLURRY PREPARATION PLANTS

The North Rawhide goal slurry preparation plant would be located adjacent to the Little Powder River in Campbell County, Wyoming. The North Rawhide Mine is bisected by Little Rawhide Creek, a major tributary to the Little Powder River. The Little Powder River, in turn, is a major tributary to the Powder River with its confluence in southeastern Montana. The Little Powder River basin can be characterized as semiarid natural short-grass plains which have been severely affected by overgrazing (Weaver and Albertson 1956, U.S. Department of the Interior 1974). Spring runoff usually occurs during late April, May and early June with maximum Little Powder River discharge approaching 1,000 cfs. Periods of zero discharge occur commonly in July and August (Wesche and Johnson 1980). During the remainder of the year, discharges are normally below 10 cfs. This discharge pattern affects benthic invertebrate production in the Little Powder River; generally, numbers and biomass are low during spring and early summer increasing to annual peak concentrations in the fall and winter (Wesche and Johnson 1980). A list of the benthic fauna of the Little Powder River appears in Table 1.

According to the U.S. Department of the Interior, Geological Survey (1976), Little Rawhide Creek is ephemeral and consequently, lacks a permanent fish fauna. During high flow periods, Little Rawhide Creek probably adds substantial amounts of coal sediment to the Little Powder River as a result of present mining activities. Fishes collected from the Little Powder River, near the North Rawhide Mine site, are listed in Table 2 (Fleischer 1978 and Wesche and Johnson 1980). Although none of the fishes potentially affected by the North Rawhide plant are officially

Table 1 TAXONOMIC CLASSIFICATION OF BENTHIC FAUNA COLLECTED FROM THE LITTLE POWDER RIVER BY WESCHE AND JOHNSON (1980)

| Order | Family | Genus |
|---|---|---|
| Diptera (two-winged flies) | Chironomidae | Chironomus sp. |
| | | Pentaneura sp. |
| | Ceratopogonidae | Palpomyia sp. |
| | Tabanidae | Chrysops sp. |
| | Culicidae | Chaoborus sp. |
| | Stratiomyiidae | Nemotelus sp. |
| | Dolichopodidae | |
| | Glossiphonidae | |
| Coleoptera (beetles) | Elmidae | Dubiraphia sp. |
| | Hydrophilidae | Berosus sp. |
| Ephemeroptera (mayflies) | Caenidae | Caenis sp. |
| Odonata (damsel and dragonflies) | Coenagrionidae | Ischnura sp. |
| | Gomphidae | Gomphus sp. |
| Trichoptera (caddisflies) | Hydropsychidae | Cheumatopsyche sp. |
| Hemiptera (water bugs) | Corixidae | |
| | Veliidae | Microvelia sp. |
| Megaloptera (hellgramites) | Sialidae | Sialis fuliginosa |
| Amphipoda (shrimp) | Talitridae | Hyallela azteca |
| Oligochaeta (worms) | Tubificidae | |
| Pulmonata (snails) | Physidae | Physa sp. |
| | Lymnaeidae | Lymnaea sp. |
| | Planorbidae | Gyraulus sp. |
| Sphaeriacea (clams) | Sphaeriidae | Sphaerium sp. |

Table 2 FISHES REPORTED FROM THE LITTLE POWDER RIVER BY THE WYOMING GAME AND FISH DEPARTMENT (FLEISCHER 1978) AND WESCHE AND JOHNSON (1980).

| Scientific Name | Common Name |
|---|---|
| FAMILY HIODONTIDAE | MOONEYES |
| *Hiodon alosoides* | Goldeye |
| FAMILY SALMONIDAE | TROUTS |
| *Salvelinus fontinalis* | Brook trout |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Hybopsis gracilis* | Flathead chub |
| *Rhinichthys cataractae* | Longnose dace |
| *Notropis stramineus* | Sand shiner |
| *Pimephales promelas* | Flathead minnow |
| *Hybognathus placitus* | Plains minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Moxostoma macrolepidotum* | Shorthead redhorse |
| *Catostomus commersoni* | White sucker |
| *Catostomus platyrhynchus* | Mountain sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus flavus* | Stonecat |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| *Micropterus salmoides*[1] | Largemouth bass |

1-found only in ponds and reservoirs in the drainage

protected, goldeye (Hiodon alosoides) are considered rare in Wyoming (Wyoming Game and Fish Department 1977). According to Scott and Crossman (1973), Wyoming is the western edge of the present range of the goldeye. Goldeye probably spawn in the Little Powder River between early April and mid-June (Hill 1966). Minnows in the Little Powder River spawn from June throughout the summer months when water levels and the stream's substrate are stable (Baxter and Simon 1970). Suckers (family Catostomidae) probably spawn between April and June (Harlan and Speaker 1951 and 1956, Deacon 1961, Baxter and Simon 1970). Catfish and green sunfish are probably summer spawners in the Little Powder River basin. The fish species present in the Little Powder River are relatively tolerant to siltation (Baxter and Simon 1970).

The proposed Jacobs Ranch coal slurry preparation plant would be situated in the Little Thunder Creek basin. Little Thunder Creek originates just south of Reno Junction and flows for 20 miles intermittently into Black Thunder Creek, a major tributary to the upper Cheyenne River (Wesche and Johnson 1980, Atlantic Richfield Co. 1973). The basin is predominantly semiarid rangeland. Plains cottonwood are common in the wide, flat floodplain. No discharge data are known for Little Thunder Creek. The benthic fauna of Little Thunder Creek displays the same seasonal trends described for the Little Powder River benthic fauna and are listed in Table 3. When water is present in Little Thunder Creek, fishes listed in Table 4 occur (Wesche and Johnson 1980). Bluegill and largemouth bass probably occur as displaced individuals from Reno Lake in the headwaters of Little Thunder Creek (Wesche and Johnson 1980, Parker 1976).

The Antelope Ranch coal slurry preparation plant site would be situated in the Antelope Creek basin. The headwaters of Antelope Creek are near Pine Ridge and flow intermittently 56 miles to the east before their confluence with the Dry Fork Cheyenne River (Wesche and Johnson 1980). The Antelope Creek Basin is basically a semiarid rangeland dominated by big sagebrush/shortgrass plains. Antelope Creek has a wide,

Table 3 TAXONOMIC CLASSIFICATION OF BENTHIC FAUNA COLLECTED FROM LITTLE THUNDER CREEK BY WESCHE AND JOHNSON (1980)

| Order | Family | Genus |
|---|---|---|
| Diptera (two-winged flies) | Chironomidae | Chironomus sp. |
| | | Pentaneura sp. |
| | Ceratopogonidae | Palpomyia sp. |
| | Tabanidae | Chrysops sp. |
| | Culicidae | Chaoborus sp. |
| Coleoptera (beetles) | Elmidae | Dubiraphia sp. |
| | Haliplidae | Haliplus sp. |
| | Hydrophilidae | Berosus sp. |
| Ephemeroptera (mayflies) | Caenidae | Caenis sp. |
| Odonata (damsel and dragonflies) | Coenagrionidae | Ischnura sp. |
| | | Argia sp. |
| Trichoptera (caddisflies) | Phryganeidae | Phryganea sp. |
| | Limnephilidae | Limnephilus sp. |
| | Psychomyiidae | Polycentropus sp. |
| Amphipoda (shrimp) | | |
| Hydracarina (water mites) | Limnocharidae | Limnochares sp. |
| Oligochaeta (worms) | Tubificidae | |
| Hirudinea (leeches) | Glossiphoniidae | |
| Polmonata (snails) | Physidae | Physa sp. |
| | Lymnaeidae | Lymnaea sp. |
| | Ancylidae | Ferrissia sp. |
| | Planorbidae | Gyraulus sp. |
| Sphaeriacea | Sphaeriidae | Sphaerium sp. |

Table 4 FISHES COLLECTED FROM LITTLE THUNDER CREEK BY WESCHE AND JOHNSON (1980)

| Scientific Name | Common Name |
|---|---|
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Pimephales promelas* | Fathead minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Catostomus commersoni* | White sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Micropterus salmoides* | Largemouth bass |

flat channel and a broad floodplain covered by stands of cottonwood and willow. Land use in the Antelope drainage basin consists mainly of livestock grazing, hay production and wildlife habitat. The benthic fauna in Antelope Creek (Table 5) is similar to the fauna in the Little Powder River and Little Thunder Creek. The fish community is also similar, except for the addition of the plains killifish (Fundulus kansae) to the fauna (Table 6). The preferred habitat of the plains killifish is shallow sandy streams and the species is relatively tolerant to high salinities and shifting sand substrates (Baxter and Simon 1970). This species is a late summer spawner (Koster 1948).

## 2.A.2 WATER SUPPLY SYSTEM

The proposed Niobrara well field water supply line would traverse approximately 67.5 miles of the Cheyenne River drainage basin in Campbell, Weston, Converse and Niobrara counties, eastern Wyoming. Streams which would be crossed by the proposed water supply line are listed in Table 7 and all of them are intermittent. The aquatic biology of the first major stream crossing, Little Thunder Creek (MP 6), was previously described in the discussion of the existing environment at the Jacobs Ranch coal slurry preparation plant (see Section 2.A.1). The floodplain traversed by the proposed waterline can be characterized as big sagebrush/shortgrass semiarid rangeland with scattered cottonwood stands along some of the streambeds. The benthic fauna of streams traversed by the proposed water supply line probably includes: dipterans (Chironomidae, Ceratopogonidae, Tabanidae and Culicidae), aquatic beetles (Elmidae, Haliplidae and Hydrophilidae), caenid mayflies, trichopterans (Limnephilidae and Psychomyiidae), odonates (Coenagrionidae), amphipods, oligochaetes, and snails (Physidae, Planorbidae, Lymnaeidae and Ancylidae). Snails are particularly abundant in some basin streams (Wesche and Johnson 1980).

A list of fishes collected by Baxter and Simon (1970) and the Wyoming Game and Fish Department (Fleischer 1978) from the Cheyenne River basin appears in Table 8. Although the plains orangethroat

Table 5 TAXONOMIC CLASSIFICATION OF BENTHIC FAUNA COLLECTED FROM ANTELOPE CREEK BY WESCHE AND JOHNSON (1980)

| Order | Family | Genus |
|---|---|---|
| Diptera (two-winged flies) | Chironomidae | *Chironomus* sp. |
| | | *Pentaneura* sp. |
| | Ceratopogonidae | *Palpomyia* sp. |
| | | *Dasyhela* sp. |
| | Tabanidae | *Chrysops* sp. |
| | | *Tabanus* sp. |
| | Culicidae | *Chaoborus* sp. |
| | Dolichopodidae | |
| | Stratiomyidae | |
| Coleoptera (beetles) | Elmidae | *Dubiraphia* sp. |
| | Hydrophilidae | *Berosus* sp. |
| | Dytiscidae | *Hydaticus* sp. |
| | Haliplidae | *Haliplus* sp. |
| Ephemeroptera (mayfly) | Caenidae | *Caenis* sp. |
| Odonata (damsel and dragonflies) | Coenagrionidae | *Ischnura* sp. |
| | | *Argia* sp. |
| | Libellulidae | *Somatochlora* sp. |
| | Aeshnidae | *Aeshna* sp. |
| Trichoptera (caddisflies) | Psychomyiidae | *Polycentropus* sp. |
| | Lymnephilidae | *Lymnephilus* sp. |
| Hemiptera (water bugs) | Corixidae | |
| | Gerridae | |
| Amphipoda (shrimp) | Talitridae | *Hyallela azteca* |
| Hydracarina (water mites) | Limnocharidae | *Lymnochares* sp. |
| Oligochaeta (worms) | Tubificidae | |
| Hirudinea (leeches) | Glossiphoniidae | |
| Polmonata (snails) | Physidae | *Physa* sp. |
| | Planorbidae | *Gyraulus* sp. |
| | Lymnacidae | *Lymnaea* sp. |
| Sphaeriacea (clams) | Sphaeriidae | *Sphaerium* sp. |

Table 6 FISHES COLLECTED FROM ANTELOPE CREEK BY WESCHE AND JOHNSON (1980)

| Scientific Name | Common Name |
|---|---|
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Hybopsis gracilis* | Flathead chub |
| *Rhinichthys cataractae* | Longnose dace |
| *Notropis stramineus* | Sand shiner |
| *Pimephales promelas* | Fathead minnow |
| *Hybognathus placitus* | Plains minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Catostomus commersoni* | White sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullheads |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus kansae* | Plains killifish |

Table 7 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE NIOBRARA WELL FIELD WATER SUPPLY LINE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Little Thunder Creek | 3 | I | Campbell |
| UT Little Thunder Creek | 4 | I | Campbell |
| Little Thunder Creek | 6 | I | Campbell |
| UT Little Thunder Creek | 7 | I | Campbell |
| UT Little Thunder Creek | 8 | I | Campbell |
| UT Piney Creek | 11 | I | Weston |
| UT Piney Creek | 11.5 | I | Weston |
| UT Piney Creek | 13 | I | Weston |
| Frog Creek | 15 | I | Weston |
| UT Frog Creek | 16 | I | Weston |
| UT Frog Creek | 20 | I | Weston |
| Keyton Creek | 23 | I | Converse |
| Cheyenne River | 24 | I | Converse |
| Wagon Hound Creek | 28 | I | Niobrara |
| UT Wagon Hound Creek | 30 | I | Niobrara |
| UT Wagon Hound Creek | 31 | I | Niobrara |
| Snyder Creek | 31.5 | I | Niobrara |
| Dogie Creek | 33 | I | Niobrara |
| UT Dogie Creek | 35 | I | Niobrara |
| UT Dogie Creek | 39.5 | I | Niobrara |
| UT Dogie Creek | 40.5 | I | Niobrara |
| UT Dogie Creek | 41 | I | Niobrara |
| UT Dogie Creek | 43 | I | Niobrara |
| Lance Creek | 49 | I | Niobrara |
| UT Lance Creek | 53 | I | Niobrara |
| Crazy Woman Creek | 57 | I | Niobrara |
| UT Crazy Woman Creek | 58 | I | Niobrara |
| Unnamed stream | 58.5 | I | Niobrara |
| UT Lance Creek | 60 | I | Niobrara |
| UT Lance Creek | 61.5 | I | Niobrara |
| Old Woman Creek | 63 | I | Niobrara |
| UT Old Woman Creek | 65 | I | Niobrara |

Table 8 FISHES REPORTED FROM THE CHEYENNE RIVER BASIN BY THE WYOMING GAME AND FISH DEPARTMENT (FLEISCHER 1978) AND BAXTER AND SIMON (1970)

| Scientific Name | Common Name |
|---|---|
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Notemigonus crysoleucas* | Golden shiner |
| *Hybopsis gracilis* | Flathead chub |
| *Rhinichthys cataractae* | Longnose dace |
| *Notropis stramineus* | Sand shiner |
| *Hybognathus placitus* | Plains minnow |
| *Pimephales notatus* | Flathead minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Catostomus commersoni* | White sucker |
| *Catostomus platyrhynchus* | Mountain sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus punctatus* | Channel catfish |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus sciadicus* | Plains topminnow |
| *Fundulus kansae* | Plains killifish |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Micropterus salmoides* | Largemouth bass |
| FAMILY PERCIDAE | PERCHES |
| *Etheostoma spectabile pulchellum* | Plains orangethroat darter |

darter is not officially protected in Wyoming it was listed as rare by Clark and Dorn (1979). This darter was originally collected in Lodgepole Creek but presently appears to be extirpated from the drainage which would not be crossed by the proposed water supply line. The only game fishes present in streams which would be traversed by the proposed water supply line are black bullheads, channel catfish, bluegill and green sunfish. Generally, these species are not present in large enough numbers nor are they of sufficient size to provide a locally important sport fishery (Wesche and Johnson 1980, Wyoming Game and Fish Commission 1971).

According to USGS gaging station records (from station 06386500, 5 miles west of the South Dakota-Wyoming state line), spring runoff in the Cheyenne River normally occurs in April and May. The maximum discharge recorded was 16,000 cfs on 27 May 1962. During late summer and early fall, however, the Cheyenne River commonly has zero discharge. From 1948 to 1974, the average discharge of the Cheyenne River was 58 cfs (U.S. Department of the Interior 1974).

According to Wesche and Johnson (1980), streams in the Cheyenne basin in eastern Wyoming are severely affected by turbidity, low dissolved oxygen levels, saline water conditions, and periodically high concentrations of heavy metals.

Streams potentially affected by Niobrara well field drawdown of the Madison Formation include the Belle Fourche and Cheyenne Rivers, Sand Creek, Crow Creek Springs, Spearfish Creek, Cascade Springs and Hot Springs. The Belle Fourche River was previously described under the North Rawhide Water Supply Line Affected Environment (Section 2.A.3). The Cheyenne River, Spearfish Creek, and Sand Creek are described under the affected environment of the Oahe Alternative Water Supply System (Section 2.G.1).

Crow Creek (from Crow Creek Springs to its confluence with Beaver Creek) has better than average water quality and production of macro-invertebrates (Stewart and Thilenius 1964). Crow Creek supports a moderate population of brown and rainbow trout (mostly stocked), white sucker, longnose sucker and longnose dace. Livestock grazing has reduced much of the riparian vegetation. Other agricultural activities in the basin and reduced volume also limit the fishery potential in Crow Creek (Stewart and Thilenius 1964). Crow Creek was rated as Class II waters (high-priority fishery resource) by the Fish and Wildlife Service and South Dakota Department of Game, Fish and Parks (1978).

Cascade Creek is short and flows into the Cheyenne River above Angostura Reservoir. It originates from Cascade Springs near Hot Springs, South Dakota. The fish fauna of Cascade Creek include rainbow and brown trout, mountain sucker, and longnose dace. These warm springs contribute to the summer lethal water temperatures that preclude a summer trout fishery in the stream. However, Cascade Creek is managed for a winter and spring trout fishery (Stewart and Thilenius 1964). The deep pools in Cascade Creek result in excellent winter and spring trout holding capacity. It is the only high quality trout stream in the southern edge of the Black Hills (Stewart and Thilenius 1964). Portions of Cascade Creek were rated as Class III waters (substantial fishery resource) by the Fish and Wildlife Service and South Dakota Department of Game, Fish and Parks (1978).

Hot Brook originates at Hot Springs and flows to the Fall River. Although no obvious reason for the reduced flow in Hot Brook can be determined, springflow nevertheless has declined (Stewart and Thilenius 1964). This stream, like Fall River, is quite warm (85°F) in summer, but can be managed as a winter and early spring fishery in lower reaches since it does not freeze. Summer and fall temperatures are lethal for trout. Livestock overgrazing has removed most riparian vegetation (Stewart and Thilenius 1964). The fish fauna of Hot Brook includes brown and rainbow trout, white sucker, mountain sucker, goldfish, longnose dace, and black bullhead.

## 2.A.3 COAL SLURRY PIPELINES AND PUMP STATIONS

### Wyoming

#### North Antelope Slurry Gathering Line.

Streams which would be traversed by the slurry gathering line between the North Antelope Ranch and Jacobs Ranch preparation plants are intermittent and are listed in Table 9. The entire 16 miles of gathering line lies in the Cheyenne River basin and would traverse the Antelope Creek, Little Thunder Creek and School Creek sub-basins.

The aquatic biology of the Antelope Creek sub-basin was previously described in the discussion of the existing environment at the North Antelope Ranch preparation plant (Section 2.A.1).

The headwaters of School Creek flow intermittently 8 miles in a northerly direction to Little Thunder Creek. Much of the upper watershed lies within the Rochelle Hills and is characterized by ponderosa pine/meadow hills and ridges. The remainder of the School Creek sub-basin is big sagebrush/shortgrass semiarid rangeland and the floodplain contains scattered plains cottonwood.

According to Wesche and Johnson (1980) only 3 species of fish occur in School Creek; fathead minnows, white suckers and black bullheads. The School Creek benthic fauna, listed in Table 10, displays the same seasonal trends for other area streams (see Section 2.A.1).

#### North Rawhide Slurry Gathering Line.

The 54 miles of slurry gathering line between the North Rawhide and Jacobs Ranch preparation plants would traverse three Wyoming drainages; the Powder, Belle Fourche and Cheyenne Rivers basins. Individual stream crossings are listed in Table 11. The aquatic biology of the intermittent tributaries to the Dry Fork Powder River (MP 2, 6 and 7)

Table 9 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE NORTH ANTELOPE SLURRY GATHERING LINE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Porcupine Creek | 1 | I | Campbell |
| UT Beckwith Creek | 2 | I | Campbell |
| UT Beckwith Creek | 3 | I | Campbell |
| UT School Creek | 8 | I | Campbell |
| UT School Creek | 8.5 | I | Campbell |
| UT School Creek | 9 | I | Campbell |
| UT School Creek | 9.5 | I | Campbell |
| School Creek | 11 | I | Campbell |
| UT Little Thunder Creek | 14 | I | Campbell |
| Little Thunder Creek | 14.5 | I | Campbell |

Table 10 TAXONOMIC CLASSIFICATION OF THE BENTHIC FAUNA COLLECTED FROM SCHOOL CREEK BY WESCHE AND JOHNSON (1980)

| Order | Family | Genus |
|---|---|---|
| Diptera (two-winged flies) | Chironomidae | *Chironomus* sp. |
| | | *Pentaneura* sp. |
| | Ceratopogonidae | *Palpomyia* sp. |
| | Tabanidae | *Chrysops* sp. |
| | Culicidae | *Chaoborus* sp. |
| Coleoptera (beetles) | Elmidae | *Dubiraphia* sp. |
| | Haliplidae | *Haliplus* sp. |
| | Hydrophilidae | *Berosus* sp. |
| Ephemeroptera (mayflies) | Caenidae | *Caenis* sp. |
| Trichoptera (caddisflies) | Limnephilidae | *Limnephilus* sp. |
| | Psychomyiidae | *Ploycentropus* sp. |
| Odonata (damsel and dragonflies) | Coenagrionidae | *Ishnura* sp. |
| Amphipoda (shrimp) | Talitridae | *Hyallela azteca* |
| Oligochaeta (worms) | Tubificidae | |
| | Hirudinea | |
| Pulmonata (snails) | Physidae | *Physa* sp. |
| | Planorbidae | *Gyraulus* sp. |
| | Lymnaeidae | *Lymnaea* sp. |
| | Ancylidae | *Ferrissia* sp. |

Table 11 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE NORTH RAWHIDE SLURRY GATHERING LINE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Dry Fork Little Powder River | 2 | I | Campbell |
| UT Dry Fork Little Powder River | 6 | I | Campbell |
| UT Dry Fork Little Powder River | 7 | I | Campbell |
| Donkey Creek | 10.5 | P | Campbell |
| UT Donkey Creek | 11 | I | Campbell |
| UT Donkey Creek | 13 | I | Campbell |
| UT Donkey Creek | 13.5 | I | Campbell |
| UT Donkey Creek | 15 | I | Campbell |
| UT Tisdale Creek | 21 | I | Campbell |
| Tisdale Creek | 22 | I | Campbell |
| Caballo Creek | 23 | I | Campbell |
| UT Caballo Creek | 25 | I | Campbell |
| UT Belle Fourche River | 28 | I | Campbell |
| Belle Fourche River | 29 | P | Campbell |
| UT Coal Creek | 34 | I | Campbell |
| E. Fork Coal Creek | 35 | I | Campbell |
| UT Middle Fork Coal Creek | 37 | I | Campbell |
| UT Middle Fork Coal Creek | 39 | I | Campbell |
| Black Thunder Creek | 47 | I | Campbell |
| UT Black Thunder Creek | 48 | I | Campbell |
| UT Little Thunder Creek | 52 | I | Campbell |

is probably similar to the Little Powder River previously described in the existing aquatic environment at the North Rawhide preparation plant (Section 2.A.1). The slurry gathering line would cross Donkey Creek at approximately MP 10.5, upstream from the Wyodak Power Plant and east of Gillette. The Belle Fourche River would be traversed at approximately MP 29. Fishes collected from the Belle Fourche River by Baxter and Simon (1970) and the Wyoming Game and Fish Department (Fleischer 1978) are listed in Table 12. The small size of the Belle Fourche River combined with fluctuating water levels precludes its use as a sport fishery (Ecological Consultants, Inc. 1976) near the proposed North Rawhide slurry gathering line crossing. Annual mean discharge of the Belle Fourche River is 67.8 cfs (Ecological Consultants, Inc. 1976). Portions of the Belle Fourche River downstream from Keyhole Reservoir provide limited angling opportunity for walleye and channel catfish (Rocket 1980). The Wyoming Game and Fish Commission (1971) reported that the Belle Fourche River below Keyhole Reservoir supports a moderate fish population (Class 4 waters). There is no significant fish habitat in the East or Middle Forks of Coal Creek (MP 35, 37 and 39) although fathead minnows may occur, seasonally (U.S. Department of the Interior 1978). The stream channels of the East and Middle Forks of Coal Creek are deeply incised and carry surface flow for less than 1 month out of the year (U.S. Department of the Interior 1978). Black Thunder Creek (MP 47) is also intermittent and may support populations of black bullheads, green sunfish and fathead minnows when water is present.

Coal Slurry Pipelines and Pump Stations.

Location and drainage characteristics of streams and rivers which would be crossed by the Proposed Action through Wyoming are listed in Table 13. The Proposed Action and water supply pipeline would be constructed in the same corridor from MP 0 to 36 and this portion of the Proposed Action is described in Section 2.A.2, above.

The Proposed Action in Wyoming would traverse the Cheyenne River basin between MP 0 and 80 and the Niobrara River basin from MP 80 to the Wyoming-Nebraska state line (MP 102). All streams which would be crossed are intermittent.

Table 12 FISHES COLLECTED REPORTED FROM THE BELLE FOURCHE RIVER DRAINAGE BY THE WYOMING GAME AND FISH DEPARTMENT (FLEISCHER 1978) AND BAXTER AND SIMON (1970)

| Scientific Name | Common Name |
| --- | --- |
| FAMILY SALMONIDAE | TROUTS |
| *Salmo gairdneri* | Rainbow trout |
| *Salmo trutta* | Brown trout |
| *Salvelinus fontinalis* | Brook trout |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Semotilus atromaculatus* | Creek chub |
| *Hybopsis gracilis* | Flathead chub |
| *Notropis stramineus* | Sand shiner |
| *Hybognathus placitus* | Plains minnow |
| *Pimephales promelas* | Flathead minnow |
| *Rhinichthys cataractae* | Longnose dace |
| *Carassilus auratus* | Goldfish |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Catostomus commersoni* | White sucker |
| *Moxostoma macrolepidotum* | Northern redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| *Micropterus salmoides* | Largemouth bass |
| FAMILY PERCIDAE | PERCHES |
| *Perca flavescens* | Yellow perch |
| *Stizostedion vitreum vitreum* | Walleye |

Table 13 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION AND MARKET ALTERNATIVE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Little Thunder Creek | 3 | I | Campbell |
| UT Little Thunder Creek | 4 | I | Campbell |
| Little Thunder Creek | 6 | I | Campbell |
| UT Little Thunder Creek | 7 | I | Campbell |
| UT Little Thunder Creek | 8 | I | Campbell |
| UT Piney Creek | 11 | I | Weston |
| Piney Creek | 11.5 | I | Weston |
| Piney Creek | 13 | I | Weston |
| Frog Creek | 15 | I | Weston |
| UT Frog Creek | 16 | I | Weston |
| UT Frog Creek | 20 | I | Weston |
| Keyton Creek | 23 | I | Converse |
| Cheyenne River | 24 | I | Converse |
| Wagon Hound Creek | 28 | I | Niobrara |
| UT Wagon Hound Creek | 30 | I | Niobrara |
| UT Wagon Hound Creek | 31 | I | Niobrara |
| Snyder Creek | 31.5 | I | Niobrara |
| Dogie Creek | 33 | I | Niobrara |
| UT Dogie Creek | 35 | I | Niobrara |
| UT Cow Creek | 35.5 | I | Niobrara |
| UT Cow Creek | 39 | I | Niobrara |
| Cow Creek | 42 | I | Niobrara |
| UT Cow Creek | 43 | I | Niobrara |
| UT Cow Creek | 45 | I | Niobrara |
| Lightning Creek | 47 | I | Niobrara |
| Lightning Creek | 47.5 | I | Niobrara |
| UT Lance Creek | 52 | I | Niobrara |
| Lance Creek | 53 | I | Niobrara |
| UT Lance Creek | 56 | I | Niobrara |
| UT Crazy Woman Creek | 58 | I | Niobrara |
| UT Crazy Woman Creek | 58.5 | I | Niobrara |
| Crazy Woman Creek | 59 | I | Niobrara |
| UT Crazy Woman Creek | 59.5 | I | Niobrara |
| UT Crazy Woman Creek | 62 | I | Niobrara |
| UT Young Woman Creek | 63.5 | I | Niobrara |
| Young Woman Creek | 64 | I | Niobrara |
| Young Woman Creek | 64.5 | I | Niobrara |
| UT Old Woman Creek | 65 | I | Niobrara |
| UT Old Woman Creek | 65.5 | I | Niobrara |
| UT Old Woman Creek | 66 | I | Niobrara |
| Old Woman Creek | 66.5 | I | Niobrara |
| UT Old Woman Creek | 68 | I | Niobrara |
| Cottonwood Creek | 74 | I | Niobrara |
| Bergreen Creek | 89.5 | I | Niobrara |
| Niobrara River | 90.5 | I | Niobrara |
| UT Niobrara River | 102 | I | Goshen |

Lance Creek, which would be crossed by the Proposed Action at approximately MP 53, has an average annual discharge of 26.3 cfs with average annual discharges varying between 2.7 cfs and 73.9 cfs (U.S. Department of the Interior 1974). Numerous small reservoirs and irrigation diversion dams affect the natural flow of Lance Creek.

Crazy Woman Creek (MP 59), near Arvada, Wyoming has a mean annual discharge of 44.7 cfs, however, the mean annual discharge between 1963 and 1970 varied between 14.5 and 102 cfs (U.S. Department of the Interior 1974). A maximum discharge of 15,000 cfs was recorded on 15 June 1965 in Crazy Woman Creek. Irrigation diversion dams and stream dewatering affect the natural flow in Crazy Woman Creek.

The biota of intermittent Wyoming streams have been previously described in Section 2.A.1 and it is likely that Lance Creek and Crazy Woman Creek maintain similar communities of fishes and invertebrates during flowing water periods.

The Niobrara River would be traversed by the Proposed Action at MP 90.5 near the Wyoming-Nebraska state line. The fishes of the section of the Niobrara River crossed by the Proposed Action are listed in Table 14. A limited brown trout fishery exists in the Niobrara River near the confluence of Van Tassel Creek, approximately 8 miles east and downstream of the proposed crossing. According to Red Rocket (1980) of the Wyoming Game and Fish Commission, the fishery has a local value since it supplies the majority of the sport fishing in that portion of the state. The finescale dace (*Phoxinus neogaeus*) and northern pearl dace (*Semotilus margarita nachtriebi*), considered rare in Wyoming by the Wyoming Game and Fish Department (1977), occur in the Niobrara River.

## Nebraska

Less than 50% of the 23,686 miles of streams and rivers in Nebraska are considered productive from a fishery standpoint (Nebraska Game and

Table 14 FISHES COLLECTED FROM THE NIOBRARA RIVER, EASTERN WYOMING BY BAXTER AND SIMON (1970).

| Scientific Name | Common Name |
|---|---|
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Semotilus atromaculatus* | Creek chub |
| *Phoxinus neogaeus* | Finescale dace |
| *Rhinichthys cataractae* | Longnose dace |
| *Notropis stramineus* | Sand shiner |
| *Hybognathus hankinsoni* | Brassy minnow |
| *Pimephales promelas* | Fathead minnow |
| *Campostoma anomalum* | Stoneroller |
| *Semotilus margarita nachtriebi* | Northern pearl dace |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Catostomus commersoni* | White sucker |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus sciadicus* | Plains minnow |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| FAMILY PERCIDAE | PERCHES |
| *Etheostoma exile* | Iowa darter |

Parks Commission 1972). Virtually all Nebraska streams are controlled by private ownership and vary in fish habitat quality from poor to fair. The Proposed Action corridor would traverse portions of the Niobrara, North Platte, South Platte and Republican drainage basins in Nebraska.

The single most important factor limiting stream productivity in Nebraska is siltation. Nearly all of Nebraska's soils are highly erodable when deprived of vegetative cover. The neglect of stream resources in land use and development programs has severely affected many Nebraska streams. In addition to siltation, the natural discharge of Nebraska rivers have been altered considerably by direct diversion for power and irrigation, by storage and releases from instream reservoirs, and by direct pump withdrawal for irrigation, industries and municipalities (Nebraska Game and Parks Commission 1972). Seasonal and permanent structural fish migration barriers exist on all major rivers and many tributaries in western Nebraska (Nebraska Game and Parks Commission 1972).

A list of fishes which could occur in streams and rivers traversed by the Proposed Action through Nebraska is presented in Table 15. This species list was compiled from distribution data presented by Morris et al. (1974) and Bliss and Schainost (1973a, b, c, d, and e). Spawning periods of these Nebraska fish families appears in Table 16.

Generally, western Nebraska's warmwater streams are dominated by populations of carp and carpsucker along with smaller populations of channel catfish and bullheads. These relatively tolerant species reflect the degradation of stream habitat in the western portion of the state. Larger streams, with backwaters and sloughs, occasionally support limited populations of largemouth bass and crappie. Some of the headwater streams flowing through Nebraska's sandhills contain remnant populations of northern pike. Spawning runs of white and striped bass and walley support a seasonal fishery in parts of the Republican River upstream from Harlan Reservoir and in the North Platte upstream from McConaughy Reservoir.

Table 15 FISHES WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION AND MARKET ALTERNATIVE PIPELINE ROUTES THROUGH NEBRASKA (DATA FROM MORRIS et al. 1974 AND BLISS AND SCHAINOST 1973a, a, c, d, and e)

| Scientific Name | Common Name |
|---|---|
| CLUPEIDAE | HERRINGS |
| Dorosoma cepedianum | Gizzard shad |
| HIODONTIDAE | MOONEYES |
| Hiodon alosoides | Goldeye |
| SALMONIDAE | TROUTS |
| Salmo gairdneri | Rainbow trout |
| Salmo trutta | Brown trout |
| Salvelinus fontinalis | Brook trout |
| ESOCIDAE | PIKES |
| Esox americanus vermiculatus | Grass pickerel |
| Esox lucius | Northern pike |
| CYPRINIDAE | MINNOWS AND CARPS |
| Campostoma anomalum | Stoneroller |
| Cyprinus carpio | Carp |
| Hybognathus hankinsoni | Brassy minnow |
| Hybognathus nuchalis | Silvery minnow |
| Hybognathus placitus | Plains minnow |
| Hybopsis gracilis | Flathead chub |
| Notemigonus crysoleucas | Golden shiner |
| Notropis atherinoides | Emerald shiner |
| Notropis cornutus | Common shiner |
| Notropis dorsalis | Bigmouth shiner |
| Notropis lutrensis | Red shiner |
| Notropis stramineus | Sand shiner |
| Phenacobius mirabilis | Suckermouth minnow |
| Pimephales notatus | Bluntnose minnow |
| Pimephales promelas | Fathead minnow |
| Rhinichthys cataractae | Longnose dace |
| Semotilus atromaculatus | Creek chub |
| CATOSTOMIDAE | SUCKERS |
| Carpiodes carpio | River carpsucker |
| Carpiodes cyprinus | Quillback |
| Catostomus catostomus | Longnose sucker |
| Catostomus commersoni | White sucker |
| Moxostoma macrolepidotum | Shorthead redhorse |

Table 15 (concluded)

| Scientific Name | Common Name |
|---|---|
| FAMILY | |
| ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus natalis* | Yellow bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus flavus* | Stonecat |
| CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus kansae* | Plains killifish |
| *Fundulus sciadicus* | Plains topminnow |
| PERCICHTHYIDAE | TEMPERATE BASSES |
| *Morone chrysops* | White bass |
| CENTRARCHIDAE | SUNFISHES |
| *Ambloplites rupestris* | Rock bass |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis gibbosus* | Pumpkin seed |
| *Lepomis humilis* | Orangespotted sunfish |
| *Micropterus dolomieui* | Smallmouth bass |
| *Micropterus salmoides* | Largemouth bass |
| *Pomoxis annularis* | White crappie |
| *Pomoxis nigromaculatus* | Black crappie |
| PERCIDAE | PERCHES |
| *Etheostoma spectabile* | Orangethroat darter |
| *Perca flavescens* | Yellow perch |
| *Stizostedion canadense* | Sauger |
| *Stizostedion vitreum* | Walleye |
| SCIAENIDAE | DRUMS |
| *Aplodinotus grunniens* | Drum |

Table 16 SPAWNING PERIODS OF NEBRASKA FISH FAMILIES OCCURRING IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY PROPOSED ACTION AND MARKET ALTERNATIVE PIPELINE ROUTES THROUGH NEBRASKA

| FAMILY | SPAWNING PERIOD |
|---|---|
| CLUPEIDAE (Herrings) | Usually May or June (Cross and Collins 1975) |
| HIODONTIDAE (Mooneyes) | Early April through early June (Hill 1966) |
| SALMONIDAE (Trouts) | Rainbow trout spawn in spring and fall (Van Velson 1978). Brook and brown trout are fall spawners (Baxter and Simon 1970) |
| ESOCIDAE (Pikes) | Early spring (Morris et al. 1974) |
| CYPRINIDAE (Minnows and Carp) | March through the summer months (Cross and Collins 1975) |
| CATOSTOMIDAE (Suckers) | Spring (Morris et al. 1974) |
| ICTALURIDAE (Catfishes) | Late spring and early summer (Morris et al. 1974) |
| CYPRINODONTIDAE (Killifishes) | Summer during high water temperatures (Morris et al. 1974) |
| PERCICHTHYIDAE (Temperate Basses) | April and early May (Cross and Collins 1975) |
| CENTRARCHIDAE (Sunfishes) | Throughout late spring and summer |

Table 16 (concluded)

| SPECIES | SPAWNING PERIOD |
|---|---|
| PERCIDAE (Perches) | Spring (Morris et al. 1974) |
| SCIAENIDAE (Drums) | Spring at 68 to 70°F (Morris et al. 1974) |

During the preparation of the state stream inventory report in 1972, Nebraska lacked waters which provided a fishery of nationwide importance (Class 1) and less than 1% of the total stream miles supported a fishery of statewide value (Table 17). Most Nebraska streams (61%) are considered degraded or nonproductive from a fishery standpoint. Most fishable Nebraska waters attract only local anglers (Class 4 waters). Table 18 lists streams and rivers crossed by the Proposed Action in Nebraska which were rated by the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission (1978).

Nebraska has cold, warm and mixed water fisheries. Coldwaters are those which support a salmonid fishery. Warmwater streams support warmwater game fish (i.e., bass, crappie, catfish, etc.) but do not support salmonids. Mixed waters are characterized by supporting both types of game fish. Coldwater streams would not be crossed by the Proposed Action in Nebraska. The North Platte River (MP 203) supports a mixed water fishery. All other streams which would be traversed support warmwater faunas.

Brook trout are confined to the headwaters of a few small streams in the White River-Hat Creek and Niobrara River drainage basins in northwestern and north-central Nebraska (Morris et al. 1974). Nebraska's brook trout fisheries are generally supported by natural reproduction. Brown trout occur in many Nebraska coldwater streams and are maintained by annual stocking (Nebraska Game and Parks Commission 1972). All Nebraska rainbow trout streams, with the exception of the McConaughy Reservoir population, are also maintained by annual stocking.

Eighty-seven percent of the coldwater salmonid habitat in Nebraska consists of McConaughy Reservoir and the upstream portion of the North Platte River to the Nebraska-Wyoming state border (Van Velson 1978). McConaughy Reservoir meets the requirements of a "two-story" reservoir described in Kirkland and Bowling (1966). McConaughy also provides excellent fishing for walleye, white bass, catfish, smallmouth bass and striped bass.

Table 17 SUMMARY OF NEBRASKA STREAMS AND RIVERS BY CLASS AND MILES (NEBRASKA GAME AND PARKS COMMISSION 1972)

| Class | Miles | Percent of State Running Waters |
|---|---|---|
| CLASS 1 (Nationwide Importance) | 0 | 0 |
| CLASS 2 (Statewide Importance) | 103 | 0.4 |
| CLASS 3 (Regional Importance) | 845 | 3.6 |
| CLASS 4 (Local Importance) | 8,280 | 35.0 |
| CLASS 5 (Degraded Waters) | 1,540 | 6.5 |
| CLASS 6 (Nonproductive Waters) | 12,918 | 54.5 |
| TOTAL | 23,686 | 100.0 |

Table 18 NEBRASKA STREAMS AND RIVERS, WITH VALUABLE FISHERY RESOURCES WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION (U.S. FISH AND WILDLIFE SERVICE AND NEBRASKA GAME AND PARKS COMMISSION 1978)

| Stream<br>Stream | MP at<br>Crossing | Classification* |
|---|---|---|
| North Platte River | 203 | Class I |
| South Platte River | 266 | Class IV |
| Stinking Water Creek | 315 | Class III |
| Blackwood Creek | 355 | Class IV |
| Republican River | 361 | Class II |

* Class I waters - highest-valued fishery resource
Class II waters - high-priority fishery resource
Class III waters - substantial fishery resource
Class IV waters - limited fishery resource

Two spawning migrations of rainbow trout occur in the McConaughy population. The fall run is the largest and extends from September into December. Most fall spawning rainbow leave McConaughy between late September and late October (Table 19). The most active spawning month of the fall spawners is December (Van Velson 1978). The spring spawning segment of McConaughy's rainbow population probably begin leaving the reservoir during late February although most of the run occurs in April (Table 19).

McConaughy rainbows migrate between 60 and 100 miles up the North Platte River to spawn. Van Velson (1978) calculated approximately 30.4 miles of suitable spawning habitat in tributaries to the North Platte River and an additional 29.6 miles which do not support natural reproduction, but do provide nursery areas for stocked trout fingerlings. The streams which provide nursery areas for McConaughy rainbows are listed in order of decreasing importance in Table 20. The stocked nursery streams are listed on Table 21. These 60 miles of trout streams were classified as natural reproduction or nursery streams based on water temperature, grazing practices, irrigation diversions, flooding, iriigation return waters, dewatering practices, migration barriers, and spawning habitat observations (Van Velson 1978).

Most of these critical spawning and nursery streams are located upstream from Bridgeport, Morrill County, Nebraska. The Proposed Action approaches the headwaters of Red Willow Creek north of the proposed North Platte River crossing (MP 203). Once the Proposed Action traverses the North Platte it runs just east of Cedar Creek.

McConaughy rainbows spawn over a variety of substrates. In the upper end of the North Platte River valley spawning usually occurs over hard compressed clay while in Otter Creek large gravel and rocks are the preferred substrate. Apparently, no reports of rainbows spawning in the mainstem of the North Platte River exist (Van Velson 1978).

Table 19 WEEK OF THE LARGEST FALL AND SPRING RAINBOW MIGRATIONS FROM McCONAUGHY RESERVOIR INTO THE NORTH PLATTE RIVER *

FALL

| Year | Week |
|---|---|
| 1967 | October 15-21 |
| 1968 | October 20-26 |
| 1969 | October 19-25 |
| 1970 | October 25-31 |
| 1971 | October 17-23 |
| 1972 | October 15-21 |
| 1973 | October 21-27 |
| 1974 | Sept. 29-Oct. 5 |

SPRING

| Year | Week |
|---|---|
| 1968 | March 10-16 |
| 1969 | April 6-12 |
| 1970 | March 22-28 |
| 1971 | March 14-20 |
| 1972 | March 5-11 |
| 1973 | March 18-24 |
| 1974 | March 10-16 |
| 1975 | March 19-25 |

* Data are from the Lewellen trap records reported by Van Velson (1978).

Table 20 TRIBUTARIES IN THE NORTH PLATTE VALLEY UTILIZED BY McCONAUGHY RESERVOIR RAINBOW TROUT FOR SPAWNING. STREAMS ARE LISTED IN ORDER OF DECREASING VALUE *

| Stream | County |
|---|---|
| Nine Mile Creek | Scotts Bluff |
| Red Willow Creek | Morrill |
| Otter Creek | Keith |
| Tub Springs | Scotts Bluff |
| Wildhorse Creek | Morrill |
| Winters Creek | Scotts Bluff |
| Dry Spottedtail Creek | Scotts Bluff |
| Sheep Creek | Scotts Bluff |

*Data are from Van Velson (1978).

Table 21 STREAMS WHICH DO NOT PROVIDE SIGNIFICANT RAINBOW TROUT SPAWNING AREAS BUT PROVIDE ESSENTIAL TROUT NURSERY AREAS *

| Stream | County |
|---|---|
| Pumpkin Creek | Banner-Scotts Bluff |
| Lonergan Creek | Keith |
| Mitchell Drain | Scotts Bluff |
| Clear Creek | Keith |
| Cedar Creek | Morrill |

*Data are from Van Velson (1978).

Water temperatures in prime rainbow spawning areas in the North Platte tributaries vary between 40 and 50°F during the fall spawn. At these water temperatures it takes between 8 to 10 weeks for rainbow larvae to hatch and emerge from the substrate. Rainbow fry move into the tributary nursery areas during the first part of February. The fry continue to develop in these nursery areas during the following summer, fall and winter. Approximately one year after hatching the juveniles begin their downstream migrations to McConaughy Reservoir. These migrating juveniles are generally between 7 and 10 inches in length. The smolt enter McConaughy during March, April and May.

The headwaters of Red Willow Creek would be approached by the Proposed Action between MP 165 and 175 in Morrill County. In this stretch the route would run approximately 7 miles northeast of the creek's headwaters. Red Willow Creek is second in importance only to Nine Mile Creek as a critical McConaughy rainbow trout spawning stream (Table 20).

The location of trout habitat in Red Willow Creek begins at the Tri-State Canal in Sec. 3, Twp. 21N, Rge. 51W. Major tributaries enter Red Willow Creek in Sec. 15, 16, 29, 32, Twp. 21N, Rge. 51W, but none provide rainbow habitat (Van Velson 1978). Prime spawning habitat in Red Willow Creek occurs in Sec. 29 and 32, Twp. 21N, Rge. 51W. The single factor most detrimental to rainbow production in Red Willow Creek is the large amounts of water released from the Tri-State Canal during irrigation season. Sometimes daily water level fluctuations occur over the entire length of Red Willow Creek resulting in stream bed scouring and excessive bank erosion. Heavy silt loads, frequent flooding and heavy grazing also influence trout production in this creek (Van Velson 1978). Fall and spring runs of rainbows spawn successfully in Red Willow Creek, although spawning concentrations are heaviest between January and March. Spawning gravel at the upper end of the Red Willow Creek drainage (Sec. 10 and 15, Twp. 21N, Rge. 51W)

is used more extensively by resident brown trout populations. Nursery stream habitat is marginal in Red Willow Creek and consequently fingerling rainbows are not stocked in this creek (Van Velson 1978).

The only other tributary to the North Platte River which would be approached by the Proposed Action is Cedar Creek which flows approximately 1/2 mile west of the Proposed Action at MP 205. Occasionally a few larger rainbows are caught near its confluence with the North Platte River, but Van Velson (1978) believes these to be strays hatched and reared in some other North Platte Valley streams. Because of the severe dewatering conditions, Cedar Creek has only limited nursery potential.

Streams and rivers which would be traversed by the Proposed Action through Nebraska are listed in Table 22. Those streams which would be crossed by the route and were rated by the Nebraska Game and Parks Commission (1972), appear in Table 23.

Niobrara River Basin. The Niobrara River basin drains approximately 11,870 square miles of northern Nebraska and contains 487 linear miles of the Niobrara River and 1,068 miles of tributary streams (Bliss and Schainost 1973a). No streams in the Niobrara River basin are classified as Class 1 waters (providing a fishery of nationwide significance).

Loss of surface stream flow severely affects the available aquatic habitat in the Niobrara River basin. Presently, water allocations for many of the small and intermediate streams are greater than the surface flow during normal or low flow years.

Nearly all Nebraska soils are highly erodable when deprived of vegetative cover. As a result of the prevailing soil conditions and the almost complete neglect of stream resources in land use and development programs, most basin streams carry high sediment loads. High turbidity affects nearly 20% of the Niobrara basin streams (Nebraska Game and Parks Commission 1972). These heavy sediment loads prevent the establishment of pools and reduces benthic production resulting in reduced fish standing crops.

Table 22 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION AND MARKET ALTERNATIVE THROUGH NEBRASKA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Niobrara River | 104 | I | Sioux |
| UT Niobrara River | 114 | I | Sioux |
| UT Niobrara River | 121 | I | Sioux |
| UT Whistle Creek | 131 | I | Sioux |
| UT Snake Creek | 136 | I | Sioux |
| Snake Creek | 145 | I | Sioux |
| Mud Springs Creek | 148 | I | Box Butte |
| UT Mud Springs Creek | 149 | I | Box Butte |
| S. Branch Snake Creek | 155 | I | Box Butte |
| Unnamed stream | 155 | I | Box Butte |
| UT Lower Dugout Creek | 193 | I | Morrill |
| Lower Dugout Creek | 196 | I | Morrill |
| UT North Platte River | 197 | I | Morrill |
| UT North Platte River | 198 | I | Morrill |
| UT North Platte River | 200.5 | I | Morrill |
| North Platte River[2] | 203 | P | Morrill |
| UT North Platte River | 209 | I | Morrill |
| Unnamed stream | 211 | I | Morrill |
| UT North Platte River | 213 | I | Morrill |
| UT North Platte River | 213.5 | I | Morrill |
| UT North Platte River | 216 | I | Garden |
| Rush Creek | 219.5 | I | Garden |
| UT Rush Creek | 220.5 | I | Garden |
| UT Rush Creek | 221.5 | I | Garden |
| UT Rush Creek | 222 | I | Garden |
| Unnamed stream | 223 | I | Garden |
| Unnamed stream | 225 | I | Garden |
| UT North Platte River | 227 | I | Garden |
| UT North Platte River | 235 | I | Garden |
| UT North Platte River | 243 | I | Garden |
| UT South Platte River | 260 | I | Keith |
| UT South Platte River | 263 | I | Keith |
| South Platte River[2] | 266 | P | Keith |
| Western Canal | 267 | P | Keith |
| Unnamed stream | 286 | I | Perkins |
| Stinking Water Creek | 315 | P | Chase |
| UT Stinking Water Creek | 322 | I | Hays |
| Fish Canyon Creek | 338 | I | Hays |
| UT Blackwood Creek | 349 | I | Hitchcock |
| UT Blackwood Creek | 351 | I | Hitchcock |
| UT Blackwood Creek | 352 | I | Hitchcock |
| UT Blackwood Creek | 353 | I | Hitchcock |
| Blackwood Creek | 355 | P | Hitchcock |
| UT Republican River | 359 | I | Red Willow |

Table 22 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Republican River[2] | 361 | P | Red Willow |
| West Canal | 361.5 | P | Red Willow |
| West Canal | 365 | P | Red Willow |
| Driftwood Creek | 365.5 | P | Red Willow |
| UT Driftwood Creek | 366 | P | Red Willow |
| UT Driftwood Creek | 367 | I | Red Willow |
| UT Beaver Creek | 374 | I | Red Willow |
| Beaver Creek | 377 | P | Red Willow |

Table 23 WATER IMPORTANCE CLASSIFICATION OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION THROUGH WESTERN NEBRASKA *

| Stream | MP | Classification (Importance) |
|---|---|---|
| Snake Creek | 155 | Degraded (Class 5) |
| North Platte River | 203 | Degraded (Class 5) |
| Rush Creek | 219.5 | Local (Class 4) |
| South Platte River | 266 | Degraded (Class 5) |
| Stinking Water Creek | 315 | Local (Class 4) |
| Blackwood Creek | 355 | Local (Class 4) |
| Republican River | 360.5 | Degraded (Class 5) |
| Driftwood Creek | 365.5 | Nonproductive (Class 6) |

* Data and classification scheme are from the Nebraska Game and Parks Commission (1972).

The Proposed Action would enter the Nebraska portion of the Niobrara River drainage basin at MP 102 (Sioux County) and would leave the basin at about MP 160 (Morrill County). Approximately 58 miles of the Proposed Action would traverse this drainage.

There are no permanent streams which would be traversed by the Proposed Action through the Niobrara River basin in Nebraska. The Niobrara River, upstream from Box Butte Reservoir was listed as Class 3 waters (regional importance) by the Nebraska Game and Parks Commission (1972) and Class 1 waters (highest-valued fishery resource) by the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission (1978). Although the Niobrara River would not be traversed by the Proposed Action in Nebraska several of its southern tributaries would be crossed (Table 22). The Niobrara River provides a corridor for spawning rainbow trout from Box Butte Reservoir. None of the Niobrara tributaries crossed by the Proposed Action are known to provide trout spawning or nursery areas (U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission 1978). Other fishes expected to occur in these intermittent tributaries during spring periods of high flow include brassy minnows, creek chubs, fathead minnows and white suckers (Bliss and Schainost 1973a). Geen et al. (1966) and Curry and Spacie (1979) have summarized the importance of intermittent streams as white sucker spawning areas.

Snake Creek, traversed by the Proposed Action at MP 155, is considered degraded (Table 22) by the Nebraska Game and Parks Commission (1972). Snake Creek drains into Kilpatrick Lake which is valued only as a local fishery.

North Platte River Basin. There are 412 miles of flowing streams within the North Platte River basin in western Nebraska. The North Platte River accounts for 164 miles of the total basin's stream mileage. Brown's Canal and the North Platte River would be the only two permanent streams traversed in the basin.

Under the existing Nebraska stream classification criteria there are no Class 1 waters (nationwide importance) in the North Platte River basin (Bliss and Schainost 1973b). The North Platte River was considered degraded (Class 5) in the section which would be traversed by the Proposed Action (Nebraska Game and Parks Commission 1972). However, its value as a trout migration corridor prompted the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission (1978) to rate it as Class 1 waters (highest-valued fishery resource). The remaining streams which would be traversed by the Proposed Action in the North Platte River basin are Class 7 waters and support isolated populations of minnows and other small fishes.

The North Platte River is dammed near Keystone, Nebraska forming Lake C. W. McConaughy. Lake McConaughy has had a significant stabilizing effect on the upstream reaches of the North Platte River. The North Platte River water supply is almost completely regulated by McConaughy Reservoir. Prior to 1941, when reservoir regulation began, periods of no flow were common the Platte River upstream from its confluence with the Loup River (Missouri River Basin Commission 1976). In the eight year period from 1934-1941, the streambed of the Platte River at Grand Island was completely dry seven times. At Overton, further west, from 1931-1941 no flow of one month duration or longer occurred seven times. In 1934 zero flow occurred from June through November. During the middle 1950's critical periods of low precipitation and heavy irrigation, industrial, and municipal water demands resulted in zero flow recordings for as long as three months at Grand Island. Minimum monthly flows at or near zero have been recorded on most of the Platte River tributaries (Missouri River Basin Commission 1976).

Because of the influence of the many sandhill streams in the basin, variations in flood flows are somewhat more erratic but less drastic than in other Nebraska basins. Typical floods in the North Platte River basin are usually caused by flood runoff from upstream.

Streams have been channelized less in the North Platte basin than in other Nebraska basins. The trend to store irrigation water in an extensive canal system has reduced the necessity of channelization to speed runoff (Bliss and Schainost 1973b). Only nine (2.1%) of the 421 stream miles in the basin have been lost to channelization.

Agricultural runoff severely affects the aquatic resources in the North Platte River basin. Bliss and Schainost (1973b) reported that 34% of all the basin's streams were affected by excessive turbidity. Unlike domestic, industrial and feed-lot wastes which enter the basin at a distinct point, agricultural runoff is spread across the entire drainage basin. Studies have shown that 92% of the nitrogen entering streams is transported by cropland sediment (Missouri River Basin Commission 1976). Agricultural sediments can contribute significantly to the biochemical oxygen demand as well as directly affecting aquatic organisms by clogging gills and destroying habitat. Turbidity problems increase as sediment content increases. In many North Platte River basin waters, sediment is the most serious pollutant restricting sport fish production (Missouri River Basin Commission 1975).

Most streams and tributaries in the North Platte River basin are over-appropriated for irrigation. During particularly dry periods, stream irrigation allocations are generally used to their fullest extent and many stream sections are reduced to zero flow during these periods (Missouri River Basin Commission 1975). Due to annual dewatering, 138 miles of the 421 stream miles in the basin are considered environmentally degraded (Class 5). Progressively greater use of ground water for irrigation in the basin has reduced ground water recharge which is essential in surface flow maintenance. Reductions in streamflow by irrigation results in concentration of polluting materials and decreases carrying capacity and standing crops in aquatic habitats.

The dumping of warm, excess irrigation water from canals and the return of excess field irrigation water to the streams severely affects

many of the critical trout spawning and nursery streams in the basin. The addition of warm irrigation water with heavy silt loads limits many of these already marginal trout streams. An increase in stream flow above the groundwater base flow is evident when the irrigation canals are filled in May and continues until they are drained in September (Van Velson 1978). Tributary stream flows then decrease slowly to low flow in March or April. Many of the North Platte River tributaries are grazed to the stream bank.

Most streams in this basin are sandy bottomed, braided and support limited warm water fisheries. Channel depths rarely exceed six feet and are more commonly between two and four feet deep. Some entrenched basin streams have deeper holes, muddy bottoms and slow moving waters.

Fishes present in the North Platte River at the Proposed Action crossing are listed in Table 24.

South Platte River Basin. At the Proposed Action crossing the South Platte River basin is approximately 15 miles wide and only five streams would be crossed. All streams which would be traversed in the basin by the Proposed Action, with the exception of the South Platte River, are intermittent (Table 22). Under the present Nebraska stream classification criteria, no streams in this basin are classified as Class 1, 2 or 3 waters (national or regional importance). The stretch of the South Platte which would be traversed by the Proposed Action is degraded (Class 5) although it does provide a limited, local channel catfish fishery. Although white bass occasionally appear in the South Platte, no sport fishery for this species exists (Bliss and Schainost 1973c). The intermittent streams which would be traversed by the Proposed Action in the basin, north of the South Platte crossing, probably support populations of minnows and shiners when water is present.

In most respects, the physical characteristcs of the South Platte basin are similar to those previously described for the North Platte River basin, although turbidity appears to be less severe in the South Platte

Table 24 FISHES COLLECTED FROM THE NORTH PLATTE RIVER NEAR THE PROPOSED ACTION CROSSING BY BLISS AND SCHAINOST (1973b)

| | |
|---|---|
| FAMILY SALMONIDAE | TROUTS |
| *Salmo gairdneri* | Rainbow trout |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Campostoma anomalum* | Stoneroller |
| *Cyprinus carpio* | Carp |
| *Hybognathus hankinsoni* | Brassy minnow |
| *Notropis dorsalis* | Bigmouth shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis stramineus* | Sand shiner |
| *Rhinichthys cataractae* | Longnose dace |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Catostomus commersoni* | White sucker |
| FAMILY ICTALURIDAE | CATFISH |
| *Ictalurus punctatus* | Channel catfish |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus sciadicus* | Plains killifish |

basin. Only 3% of the South Platte basin streams have been channelized and the most severe factor limiting fish production appears to be sedimentation and dewatering (Bliss and Schainost 1973c). Channel catfish would probably be the only sport fish occurring at the Proposed Action crossing of the South Platte River. Other fishes present in the basin are listed in Table 25.

These streams probably maintain a macroinvertebrate community similar to that described by Wesche and Johnson (1980) including Diptera (flies), Coleoptera (beetles), Ephemeroptera (mayflies), Hemiptera (bugs), Odonata (dragonflies and damselflies), other insects, and aquatic worms and various mollusks.

Republican River Basin. According to Bliss and Schainost (1973d), 37 species of fish occur in the Republican River drainage. Game fish present in the basin include channel catfish, black bullheads, white and black crappie, northern pike, bluegill, largemouth and smallmouth bass, rock bass, white bass, and walleye. Streams containing sport fish populations which would be traversed by the Proposed Action in the Republican River basin are Stinking Water Creek (MP 315) and the Republican River (MP 361).

Stinking Water Creek would be traversed by the Proposed Action just south of the Perkins-Chase county line. Fishes present in this section of Stinking Water Creek include black bullheads, brassy minnows, channel catfish, creek chubs, fathead minnows, red shiners and sand shiners. Stinking Water Creek may provide some local angling opportunities, when water is present (Bliss and Schainost 1973d). About 3% of the stream has been lost to channelization. Spawning white bass from the Republican River may utilize the lower sections of Stinking Water Creek in the spring.

The Proposed Action would be aligned through Sand Hills parallel to the lower portions of Stinking Water and Frenchman Creeks. Walleye occur in Frenchman Creek immediately downstream of Enders Reservoir. Populations of walleye in Frenchman Creek are probably the result of downstream migration from the upstream reservoir.

Table 25 FISHES WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION THROUGH THE SOUTH PLATTE DRAINAGE BASIN, NEBRASKA (MORRIS et al. 1974)

| | |
|---|---|
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Campostoma anomalum* | Stoneroller |
| *Cyprinus carpio* | Carp |
| *Hybognathus hankinsoni* | Brassy minnow |
| *Hybognathus nuchalis* | Silvery minnow |
| *Notropis dorsalis* | Bigmouth shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis stramineus* | Sand shiner |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Pimephales promelas* | Fathead minnow |
| *Rhinichthys cataractae* | Longnose dace |
| *Semotilus atromaculatus* | Creek chub |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Catostomus catostomus* | Longnose sucker |
| *Catostomus commersoni* | White sucker |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus kansae* | Plains killifish |
| *Fundulus sciadicus* | Plains topminnow |
| FAMILY PERCICHTAYIDAE | TEMPERATE BASSES |
| *Morone chrysops* | White bass |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |

Blackwood Creek would be traversed by the Proposed Action at MP 355 in Hitchcock County. The ichthyofauna of Blackwood Creek consists entirely of nonsport species including creek chubs, fathead minnows and red shiners (Bliss and Schainost 1973d).

The Republican River would be traversed by the Proposed Action at MP 361, just east of the Red Willow-Hitchcock county line. The Republican River is comparatively shallow and slow moving and the streambed consists primarily of sand. Steep banks prevail in some areas (Messman 1973). The river channel is interlaced with sand bars that support dense stands of willow and cottonwood. The stream is mostly free of the scouring action of floods. Portions of the banks are severly eroded. The Proposed Action crossing would occur downstream of Swanson Reservoir and upstream of Harlan County Reservoir. Fishes collected by Bliss and Schainost (1973d) from this portion of the Republican River include bluegill, brassy minnows, carp, channel catfish, emerald shiners, fathead minnows, gizzard shad, plains killifish, river carpsucker, red shiners and sand shiners. A locally valuable sport fishery exists in the Republican River (Bliss and Schainost (1973d). Channel catfish are probably the most commonly taken species.

Kansas

Kansas has two major river systems, the Arkansas and Missouri. In the Missouri River system, the Proposed Action would traverse the Upper Republican, Solomon, Saline and Smoky Hill River basins (Table 26 ). The Upper and Lower Arkansas River basins comprise the portion of the Arkansas River system which would be traversed by the Proposed Action corridor. Most rivers in western Kansas have sandy, relatively unproductive bottoms and generally lack diverse benthic and fish habitat (Cross and Collins 1975). These stream bottoms are generally leveled when stream flow is constant. Rocky bottomed streams in southeastern Kansas may have as many as 30 fish species whereas the sandy bottomed western streams typically have less than 10 environmentally tolerant species. Tributaries to large western Kansas rivers typically have a more diverse fish fauna than do

Table 26 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION THROUGH KANSAS
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Beaver Creek | 379 | I | Decatur |
| UT Sappa Creek | 381 | I | Decatur |
| UT Sappa Creek | 381.5 | I | Decatur |
| Sappa Creek | 388 | P | Decatur |
| UT Sappa Creek | 390.5 | I | Decatur |
| UT Sappa Creek | 394 | I | Decatur |
| UT Sappa Creek | 394.5 | I | Decatur |
| UT Big Timber Creek | 396 | I | Decatur |
| UT Big Timber Creek | 398 | I | Decatur |
| UT Big Timber Creek | 401 | I | Decatur |
| Big Timber Creek | 402 | I | Decatur |
| Big Timber Creek | 402.5 | I | Decatur |
| Big Timber Creek | 403 | I | Decatur |
| Big Timber Creek | 403.5 | I | Decatur |
| Prairie Dog Creek | 405 | I | Decatur |
| UT Elk Creek | 408 | I | Decatur |
| UT N. Fork Solomon River | 414 | I | Norton |
| UT N. Fork Solomon River | 414.5 | I | Norton |
| N. Fork Solomon River | 415 | P | Norton |
| UT N. Fork Solomon River | 416 | I | Norton |
| UT N. Fork Solomon River | 418 | I | Norton |
| UT N. Fork Solomon River | 419 | I | Norton |
| UT Bow Creek | 421 | I | Graham |
| UT Bow Creek | 422 | I | Graham |
| Bow Creek | 424 | I | Graham |
| UT Rock Creek | 428 | I | Graham |
| UT S. Fork Solomon River | 433 | I | Graham |
| S. Fork Solomon River | 435 | P | Graham |
| Jackson Branch | 439.5 | I | Graham |
| UT Jackson Branch | 440 | I | Graham |
| UT Jackson Branch | 443 | I | Graham |
| UT Saline River | 445 | I | Graham |
| UT Saline River | 448 | I | Graham |
| UT Saline River | 453 | I | Graham |
| UT Saline River | 453.5 | I | Graham |
| Saline River | 456 | P | Trego |
| Shaw Creek | 458 | I | Trego |
| UT Shaw Creek | 459 | I | Trego |
| UT Saline River | 461 | I | Trego |
| UT Spring Creek | 464 | I | Trego |
| UT Big Creek | 467 | I | Trego |
| UT Big Creek | 467.5 | I | Trego |
| UT Big Creek | 468 | I | Trego |
| UT Big Creek | 468.5 | I | Trego |
| UT Big Creek | 469 | I | Trego |
| UT Big Creek | 470 | I | Trego |

Table 26 (continued)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Big Creek | 471 | P | Trego |
| UT Big Creek | 471.5 | I | Trego |
| UT Smoky Hill River | 473 | I | Ellis |
| UT Big Creek | 475 | I | Ellis |
| UT Smoky Hill River | 477 | I | Ellis |
| UT Smoky Hill River | 480.5 | I | Ellis |
| UT Smoky Hill River | 482 | I | Ellis |
| UT Smoky Hill River | 482.5 | I | Ellis |
| UT Smoky Hill River | 483 | I | Ellis |
| UT Smoky Hill River | 483.5 | I | Ellis |
| UT Smoky Hill River | 484 | I | Ellis |
| UT Smoky Hill River | 486 | I | Ellis |
| UT Smoky Hill River | 488 | I | Ellis |
| UT Smoky Hill River | 490 | I | Ellis |
| Smoky Hill River | 492 | P | Ellis |
| UT Smoky Hill River | 493 | I | Rush |
| Big Timber Creek | 497 | I | Rush |
| UT Smoky Hill River | 500 | I | Rush |
| UT Smoky Hill River | 501 | I | Rush |
| UT Sand Creek | 506 | I | Rush |
| UT Walnut Creek | 509 | I | Rush |
| UT Walnut Creek | 510.5 | I | Rush |
| Walnut Creek | 513 | P | Rush |
| UT Walnut Creek | 518 | I | Rush |
| Dry Walnut Creek | 523 | P | Barton |
| UT Dry Walnut Creek | 524 | I | Barton |
| UT Dry Walnut Creek | 525 | I | Barton |
| UT Dry Walnut Creek | 525.5 | I | Barton |
| UT Dry Walnut Creek | 528 | I | Barton |
| Arkansas River[2] | 532 | P | Barton |
| Rattlesnake Creek | 551 | P | Stafford |
| Peace Creek | 558 | P | Stafford |
| UT N. Fork Ninnescah River | 561.5 | I | Stafford |
| UT N. Fork Ninnescah River | 563 | I | Stafford |
| UT N. Fork Ninnescah River | 565 | I | Stafford |
| UT N. Fork Ninnescah River | 566 | I | Stafford |
| N. Fork Ninnescah River | 567 | P | Stafford |
| UT N. Fork Ninnescah River | 567.5 | I | Stafford |
| UT Wolf Creek | 575 | I | Reno |
| UT Silver Creek | 577 | I | Reno |
| Silver Creek | 580 | P | Reno |
| Goose Creek | 583 | P | Kingman |
| UT S.F. Ninnescah River | 587 | I | Kingman |
| UT Ninnescah Lake | 588 | I | Kingman |

Table 26 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT S.F. Ninnescah River | 591 | I | Kingman |
| S.F. Ninnescah River | 593 | P | Kingman |
| UT S.F. Ninnescah River | 594 | I | Kingman |
| Wild Run Creek | 595 | I | Kingman |
| UT S.F. Ninnescah River | 597 | I | Kingman |
| Hunter Creek | 598 | I | Kingman |
| UT Red Creek | 601 | I | Kingman |
| UT Red Creek | 602 | I | Kingman |
| UT Red Creek | 603 | I | Kingman |
| Rosebud Creek | 606 | I | Kingman |
| UT Rosebud Creek | 606.5 | I | Kingman |
| Chikaskia River | 610 | P | Kingman |
| UT Chikaskia River | 611.5 | I | Kingman |
| UT Chikaskia River | 617 | I | Harper |
| UT Spring Creek | 621 | I | Harper |
| UT Spring Creek | 622 | I | Harper |
| Spring Creek | 624 | I | Harper |
| Sand Creek | 628 | P | Harper |
| UT Sand Creek | 629 | P | Harper |
| UT Sand Creek | 630.5 | P | Harper |
| Fall Creek | 633 | P | Sumner |
| Fall Creek | 634 | P | Sumner |
| UT Fall Creek | 635 | I | Sumner |
| UT Fall Creek | 637 | I | Sumner |
| Spring Creek | 642 | I | Sumner |
| UT Spring Creek | 642.5 | I | Sumner |
| UT Fall Creek | 643 | I | Sumner |
| UT Fall Creek | 644 | I | Sumner |
| UT Fall Creek | 648 | I | Sumner |
| Fall Creek | 648.5 | P | Sumner |
| Bluff Creek | 649 | P | Sumner |

the mainstems (Kilgore and Rising 1965). Where streams in western Kansas depend on surface drainage they are usually dry most of the year (Breukelman 1940). Where such streams cut their valleys into Tertiary strata they are supplied by springs that insure a continuous flow year-round. Western Kansas streams have much dissolved material but little suspended matter except during periods of high flow (Breukelman 1940). Cultivation of adjacent lands has increased the sediment loads.

Few truly aquatic plants exist in western Kansas flowing waters (Brooks and Hauser 1978) and those that do are found in relatively clear streams with sandy or gravelly bottoms. The flora of these streams include water purslane (Didiplis diandra), water starwort (Callitriche heterophylla), white water-crowfoot (Ranunculus longirostris), and water stargrass (Heteranthera dubia). Backwater areas and river oxbows may contain mosquito fern (Azolla mexicana) and American lotus (Nelumbo lutea).

Freshwater unionid mussels which could occur in streams and rivers traversed by the Proposed Action are listed in Table 27. Of course, mussels in Kansas are limited to permanent waters and found only rarely in streams with shifting sand substrates which explains the paucity of mussels in western Kansas north of the Arkansas River. Generally, Kansas freshwater mussels have a high tolerance to turbidity but are less tolerant to industrial pollutants (Murray and Leonard 1962).

Crayfish occurring in aquatic habitats which would be traversed by proposed pipeline routes through Kansas are all members of the subfamily Cambarinae and represent the genera Procambarus and Orconectes (Williams and Leonard 1952). According to Williams and Leonard only 3 species of crayfish occur in streams and rivers traversed by proposed pipeline routes. Orconectes nais has a statewide distribution and occurs commonly in ponds, streams and ditches, mostly where substrates

Table 27 UNIONID MUSSELS WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION OR MARKET ALTERNATIVE THROUGH KANSAS (MURRAY AND LEONARD 1962)

| SPECIES | DRAINAGE |
|---|---|
| POND-HORN MUSSEL<br>*(Uniomerus tetralasmus)* | Upper and Lower Arkansas River basins |
| FLOATER MUSSEL<br>*(Anodonta grandis)* | Solomon, Saline, Smokey Hill, Upper and Lower Arkansas River basins |
| FLOATER MUSSEL<br>*(Anodonta imbecelis)* | Eastern half of Lower Arkansas River basin |
| SQUAW-FOOT MUSSEL<br>*(Strophitus rugosus)* | Eastern half of Lower Arkansas River basin |
| DEER-TOE MUSSEL<br>*(Truncilla truncata)* | Eastern third of Lower Arkansas River basin |
| FRAGILE PAPER MUSSEL<br>*(Leptodea fragilis)* | Eastern quarter of Lower Arkansas River basin |
| PAPER-SHELL MUSSEL<br>*(Leptodea laevissima)* | Arkansas River |
| PURPLE SHELL MUSSEL<br>*(Proptera purpurata)* | Eastern quarter of Lower Arkansas River basin |
| LILLIPUT MUSSEL<br>*(Carunculina parva)* | Throughout the entire Lower Arkansas River basin |

Table 27 (concluded)

| SPECIES | DRAINAGE |
|---|---|
| COMMON POND MUSSEL *(Ligumia subrostrata)* | Eastern quarter of Lower Arkansas River basin |
| YELLOW SAND-SHELL MUSSEL *(Lampsilis anodontoides anodontoides)* | Eastern third of Lower Arkansas River basin |

are free of submerged vegetation and debris, or in situations where the water is choked with such materials (Williams and Leonard 1952). O. nais is not abundant in sandy western Kansas streams and only occasionally burrows in stream banks. Historical records of Orconectes neglectus exist for Cheyenne and Decatur counties although it's presently restricted to the Kansas River in east-central Kansas and Cherokee County. Procambarus simulans, although apparently uncommon in western Kansas sandy streams, is present in small ephemeral pools in the western portion of the state (Williams and Leonard 1952).

Fishes which could occur in streams and rivers which would be traversed by the Proposed Action through Kansas are listed in Table 28. This list was compiled from distribution data presented by Cross and Collins (1975). A description of the spawning periods of each family occurs in Table 29.

From north to south the Proposed Action corridor through Kansas would traverse the following drainage basins:

- Upper Republican River Basin
- Solomon River Basin
- Saline River Basin
- Smoky Hill River Basin
- Upper Arkansas River Basin
- Lower Arkansas River Basin

A list of individual streams and rivers which would be traversed by the Proposed Action through Kansas appears in Table 26.

Upper Republican River Basin. Sappa Creek would be traversed by the Proposed Action at approximately MP 388 in Decatur County, Kansas, west of Oberlin-Sappa State Park. Near the proposed crossing the width of Sappa Creek ranges between 7 and 10 feet and average depth is between 6 and 10 inches (Kansas Forestry, Fish and Game Commission 1977a). Stream banks are

Table 28 FISHES WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION THROUGH KANSAS (DISTRIBUTION DATA FROM CROSS AND COLLINS 1975)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY POLYODONTIDAE | PADDLEFISHES |
| Polyodon spathula | Paddlefish |
| FAMILY LEPISOSTEIDAE | GARS |
| Lepisosteus platostomus | Shortnose gar |
| Lepisosteus osseus | Longnose gar |
| FAMILY ANGUILLIDAE | FRESHWATER EELS |
| Anguilla rostrata | American eel |
| FAMILY CLUPEIDAE | HERRINGS |
| Alosa chrysochloris | Skipjack herring |
| Dorosoma cepedianum | Gizzard shad |
| FAMILY HIODONTIDAE | MOONEYES |
| Hiodon alosoides | Goldeye |
| FAMILY SALMONIDAE | TROUTS |
| Salmo gairdneri | Rainbow trout |
| FAMILY ESOCIDAE | PIKES |
| Esox lucius | Northern pike |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| Cyprinus carpio | Carp |
| Carassius auratus | Goldfish |
| Notemigonus crysoleucas | Golden shiner |
| Semotilus atromaculatus | Creek chub |
| Hybopsis storeriana | Silver chub |
| Hybopsis aestivalis | Speckled chub |
| Phenacobius mirabilis | Suckermouth minnow |
| Notropis atherinoides | Emerald shiner |
| Notropis rubellus | Rosyface shiner |
| Notropis umbratilis | Redfin shiner |
| Notropis cornutus | Common shiner |
| Notropis blennius | River shiner |
| Notropis boops | Bigeye shiner |
| Notropis camurus | Bluntface shiner |
| Notropis lutrensis | Red shiner |

Table 28 (continued)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| Notropis stramineus | Sand shiner |
| Notropis girardi | Arkansas River shiner |
| Notropis volucellus | Mimic shiner |
| Notropis buchanani | Ghost shiner |
| Hybognathus hankinsoni | Brassy minnow |
| Hybognathus placitus | Plains minnow |
| Pimephales promelas | Fathead minnow |
| Pimephales vigilax | Bullhead minnow |
| Pimephales tenellus | Slim minnow |
| Pimephales notatus | Bluntnose minnow |
| Campostoma anomalum | Stoneroller |
| FAMILY CATOSTOMIDAE | SUCKERS |
| Ictiobus cyprinellus | Bigmouth buffalo |
| Ictiobus niger | Black buffalo |
| Ictiobus bubalus | Smallmouth buffalo |
| Carpiodes cyprinus | Quillback |
| Carpiodes carpio | River carpsucker |
| Minytrema melanops | Spotted sucker |
| Moxostoma erythrurum | Golden redhorse |
| Moxostoma macrolepidotum | Shorthead redhorse |
| Catostomus commersoni | White sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| Ictalurus melas | Black bullhead |
| Ictalurus natalis | Yellow bullhead |
| Ictalurus punctatus | Channel catfish |
| Ictalurus furcatus | Blue catfish |
| Pylodictis olivaris | Flathead catfish |
| Noturus nocturnus | Freckled madtom |
| Noturus flavus | Stonecat |
| Noturus miurus | Brindled madtom |
| FAMILY CYPRINODONTIDAE | TOPMINNOWS & KILLIFISHES |
| Fundulus notatus | Blackstripe topminnow |
| Fundulus kansae | Plains killifish |
| FAMILY POECILIIDAE | MOSQUITOFISHES |
| Gambusia affinis | Mosquitofish |

Table 28 (concluded)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY ATHERINIDAE | SILVERSIDES |
| Labidesthes sicculus | Brook silverside |
| FAMILY PERCICHTHYIDAE | TEMPERATE BASSES |
| Morone saxatilis | Striped bass |
| Morone chrysops | White bass |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| Micropterus dolomieui | Smallmouth bass |
| Micropterus punctulatus | Spotted bass |
| Micropterus salmoides | Largemouth bass |
| Lepomis gulosus | Warmouth |
| Lepomis cyanellus | Green sunfish |
| Lepomis macrochirus | Bluegill |
| Lepomis humilis | Orangespotted sunfish |
| Lepomis megalotis | Longear sunfish |
| Pomoxis annularis | White crappie |
| Pomoxis nigromaculatus | Black crappie |
| FAMILY PERCIDAE | PERCHES |
| Stizostedion vitreum | Walleye |
| Percina phoxocephala | Slenderhead darter |
| Percina caprodes | Logperch |
| Percina copelandi | Channel darter |
| Etheostoma whipplei | Redfin darter |
| Etheostoma cragini (a,b) | Arkansas darter |
| Etheostoma spectabile | Orangethroat darter |
| FAMILY SCIAENIDAE | DRUMS |
| Aplodinotus grunniens | Freshwater drum |

(a) Threatened (Kansas Fish and Game, K. S. A. 32-501-510; May 1, 1978).

(b) Depleted (Miller 1972).

Table 29 SPAWNING PERIODS OF KANSAS FISH FAMILIES OCCURRING IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION PIPELINE CORRIDOR

| FAMILY | SPAWNING PERIOD |
|---|---|
| POLYODONTIDAE (Paddlefishes) | April to May during high spring river levels after water temperatures have reached 50 or 60°F (Pflieger 1975). |
| LEPISOSTEIDAE (Gars) | June (Deacon 1961) |
| CLUPEIDAE (Herrings) | May through June (Cross and Collins 1975) |
| HIODONTIDAE (Mooneyes) | Probably late April to early July (Pflieger 1975) |
| SALMONIDAE (Trouts) | We are unaware of any naturally reproducing trout populations in Kansas. All Kansas trout fisheries consist of stocking catchable size fish (Cross and Collins 1975) |
| ESOCIDAE (Pikes) | Late winter or early spring (Cross and Collins 1975) |
| CYPRINIDAE (Minnows and Carps) | This family spawns from March through the summer months in Kansas (Cross and Collins 1975) |
| CATOSTOMIDAE (Suckers) | April to July when spring rains result in high water levels (Cross and Collins 1975) |

Table 29 (concluded)

| FAMILY | SPAWNING PERIOD |
|---|---|
| ICTALURIDAE (Catfishes) | Nesting occurs in Kansas in late spring through early summer; May to July (Cross and Collins 1975) |
| CYPRINODONTIDAE (Topminnows and Killifishes) | May through mid-August (Cross and Collins 1975) |
| POECILIIDAE (Mosquitofishes) | The only family of fish in Kansas which gives both to young rather than depositing eggs. Litters are produced repeatedly during the summer (Cross and Collins 1975) |
| ATHERINIDAE (Silversides) | May through July (Cross and Collins 1975) |
| PERCICHTHYIDAE (Temperate Basses) | April and early May (Cross and Collins 1975) |
| CENTRARCHIDAE (Sunfishes) | Late spring throughout the early summer months (Cross and Collins 1975) |
| PERCIDAE (Perches) | Walleye - March and April<br>Darters - March to May<br>(Cross and Collins 1975) |
| SCIAENIDAE (Drums) | May through July (Cross and Collins 1975) |

steep, usually 10-15 feet high, and composed primarily of clay. Riparian vegetation is moderately sparse with large dead cottonwoods occurring in areas. Aquatic vegetation is sparse, but includes duckweed, filamentous algae, Ranunculus and Typha. Little angling opportunity exists in the area although occasionally black bullheads are taken from some of the deeper pools. Other fishes present include fathead minnows and carp. The sand and mud substrate supports odonates, amphipods, clams, chironomids, dytiscids, and snails. Back swimmers, water striders, leeches and water boatmen are also present.

Prairie Dog Creek would be traversed at approximately MP 405 in Decatur County near Highway 383. The crossing is approximately 25 miles upstream of Norton Reservoir. Irrigation demands downstream from Norton Reservoir have resulted in minimal flows in this region and consequently an obvious loss in fish habitat. Due to agricultural cultivation in the basin, agricultural pollution is quite extensive. The width of Prairie Dog Creek varies between 6 and 24 feet while mean depth ranges between 0.7 and 1.7 feet during fall flow conditions. During the fall, discharge is usually about 1 cfs. The stream banks are 4 to 12 feet high and covered by native grasses and forbs. In flatter areas ragweed, sunflowers, and small clumps of cottonwoods grow adjacent to the stream. Small stands of sandbar willow can be found near the waterline. In other areas elm, boxelder, and green ash dominate the riparian tree stands (Kansas Forestry, Fish and Game Commission 1977a). Aquatic vegetation consisting of colonial and filamentous green algae is abundant in places. The stream substrate is mostly sand, silt and mud with some large cobble, rubble and sunken logs. Aquatic invertebrates in Prairie Dog Creek include clams, crayfishes, water striders, water boatmen, back swimmers, whirlygig beetles, odonates, mayflies, snails and freshwater shrimp. Although sport fishes including channel catfish, largemouth bass, bullheads, carp and green sunfish are present in Prairie Dog Creek, angling opportunities are limited and most fishing occurs where the stream is pooled by beaver dams. Forage fishes present in Prairie Dog Creek include sand shiners, fathead minnows, red shiners, orangethroat darters, creek chubs, and bluntnose minnows.

Solomon River Basin. The first major stream which would be crossed in the Solomon River basin would be the North Fork Solomon River (MP 415). During the November 1975 stream survey of the North Fork Solomon River by the Kansas Forestry, Fish and Game Commission (1977b), the entire stream bed was dry and colonized by terrestrial vegetation including small willows and cottonwoods. Along with drought conditions, the expansion of deep well irrigation within the valley's alluvium affects the surface water conditions as surface water in this area is dependent upon recharge by ground water. During these periods of drought, resident fish populations must move downstream toward Kirwin Reservoir or perish. Fishes of the North Fork Solomon River above Kirwin Reservoir include green sunfish, creek chubs, red shiners, sand shiners, fathead minnows and stonerollers. Angling in the North Fork Solomon River upstream from Kirwin Reservoir is limited by the prevailing water conditions. If downstream flow is sufficient and the reservoir near conservation level, angling for channel catfish and spring spawning white bass is excellent near the reservoir. Normally, however, water levels allow only limited upstream migration of these game fishes because of mill dam obstructions. Those species that do manage to move upstream are normally stranded in small isolated pools as upstream irrigation and the city of Phillipsburg water demands either significantly diminish or stop flow in the North Fork Solomon River (Kansas Forestry, Fish and Game Commission 1977b).

In the reach of the South Fork Solomon River (MP 435) which would be crossed by the Proposed Action the average stream width is 8 feet. Winter discharge reported by the Kansas Forestry, Fish and Game Commission (1977b) was 1.25 cfs. The stream runs through agricultural areas and the lack of riparian vegetation is attributed to heavy cattle use. Banks are gently sloping and devoid of ground cover or trees.

The sandy substrate supports odonates, caddisflies and mayflies. Aquatic vegetation is primarily limited to attached algae although isolated patches of duckweed and a few large rushes occur in protected areas. The

ichthyofauna is composed of more tolerant species including creek chubs, stonerollers, green sunfish, plains killifish and orangethroat darters. Angling in this stretch of the South Fork Solomon River is practically nonexistent.

Saline River Basin. The Saline River would be crossed by the Proposed Action at approximately MP 456, northeast of Wakeeney in Trego County, Kansas. Except for a few small isolated pools, the stream bed is dry in the summer (Kansas Fish and Game Commission 1979a). The stream bed is composed primarily of sand and the banks covered with native grasses and forbs. Average stream width and depth near the proposed crossing is 8 feet and 3 inches, respectively.

The overstory of large willows and a few cottonwoods provides some shading of the stream. Aquatic invertebrates are limited to chironomids and a few whirlygig beetles. Aquatic vegetation in the area is blue-green and green algae. No angling opportunities exist in the area because the fish fauna is limited to sand shiners, red shiners and fathead minnows.

Smoky Hill River Basin. Two permanent streams, Big Creek and the Smoky Hill River, would be crossed in the Smoky Hill Basin.

Big Creek would be crossed by the Proposed Action at MP 471 on the Trego-Ellis county line. Near the proposed crossing, Big Creek varies between 20 and 37.5 feet in width and has an average depth of 13.2 inches (Kansas Fish and Game Commission 1979b). A February discharge of 10.5 cfs was recorded by the Kansas Fish and Game Commission in 1975. For the most part, this section of Big Creek runs through agricultural lands. The stream bed consists of sand and fine gravel with a covering of silt in some portions of the creek. Willow limbs provide superior fish cover in Big Creek. A few large peach-leaved willows and scattered cottonwoods provide some stream shading. Filamentous green algae are abundant on the bottom of Big Creek.

Megalopterans, snails, amphipods, and damselflies are common in this section of Big Creek. Chironomids, annelids and caddisfly larvae are abundant. Dytiscids occur less frequently. This portion of Big Creek provides some angling for black bullheads, carp, green sunfish, bass and channel catfish. White crappie are also present but scarce. Forage fish species include red shiners, sand shiners, fathead minnows and stonerollers.

The Proposed Action would traverse the Smoky Hill River at MP 492 in Ellis County, downstream from Cedar Bluff Reservoir. Near the proposed crossing the Smoky Hill River varies between 11.5 and 28.5 feet in width and has an average depth of 6 inches. A July discharge of 7.5 cfs was recorded by the Kansas Fish and Game Commission (1979b) in 1975. The stream bed consists of fine sand with a few rocks and fine gravel in the main channel. The stream receives heavy cattle use. Sedges, willows and cottonwoods are common and provide some stream shading along the banks. Cattails occur infrequently.

The benthic fauna is comprised of mayflies, caddisflies, chironomids and damselflies. Nonsport fishes present in this portion of the Smoky Hill River include creek chubs, suckermouth minnows, red shiners, sand shiners, and plains killifish. Channel catfish are taken when increased flow scours out the deeper holes, which are otherwise filled with sand (Kansas Fish and Game Commission 1979b).

Upper Arkansas River Basin. Three permanent streams would be crossed in the upper Arkansas River basin; Walnut Creek, Dry Creek and the Arkansas River.

Walnut Creek (Wet Walnut Creek) would be traversed at MP 513. Near the proposed crossing Walnut Creek varies between 10 and 60 feet in width with a mean depth of 2.5 feet. The water level in Walnut Creek is severely depressed by heavy irrigation demands (Kansas Forestry, Fish and Game

Commission 1977c). The banks slope rapidly and are eroded. The steambed is composed of sand and silt with many snags and dead falls present. Both banks are undercut.

Woody riparian vegetation consists of cottonwood, willow, ash, hackberry, boxelder and cedar. The understory and bank cover is primarily giant ragweed, foxtail and gourd. Apparently, aquatic vegetation is lacking.

Crayfish are common in Walnut Creek. Most fishing in this portion of Walnut Creek is for carp and success is rated from poor to good depending on stream conditions (Kansas Forestry, Fish and Game Commission 1977c). Channel catfish, black bullheads, green sunfish and orange-spotted sunfish are common. Red shiners and sand shiners comprise the forage portion of Walnut Creek's fish population.

Dry Walnut Creek would be traversed by the Proposed Action at MP 523 in Barton County, Kansas. The segment of Dry Walnut Creek which would be crossed varies between 21 and 62 feet in width and has an average depth of 2.5 feet. The highly erodable stream sides range from 4 to 30 feet in height and are abrupt (Kansas Forestry, Fish and Game Commission 1977c). The streambed consists of large rocks, sand and areas of light silt deposition.

The overstory consists of ash, boxelder, hackberry and elm and is usually dense enough to preclude development of a significant understory. Angling occurs in Dry Walnut Creek year-round. Fishing for channel catfish and carp is particularly good when the Cheyenne Waterfowl Management Area diverts water from the Arkansas River into the management pools. Other marketable or sportfishes present in the section of Dry Walnut Creek which would be traversed by the Proposed Action include largemouth bass, black bullheads, green sunfish, white crappie and river carpsucker. Nonsport species present are red and sand shiners.

The Proposed Action would cross the Arkansas River at MP 532 (Table 25) in Barton County, between Pawnee Rock and Great Bend, Kansas. At the proposed crossing, the Arkansas River varies in width from 25 to 150 feet. Average depth is 2 feet. The abrupt stream banks range from 1 to 10 feet in height and are covered with native grasses and woody vegetation. The substrate of this portion of the Arkansas River is composed of sand and gravel with scattered pockets of silt (Kansas Forestry, Fish and Game Commission 1977c). Some rock, rubble and scattered brush and snags are present. Riparian timber displays a pocketed pattern and consists of cottonwood and willow. Little bluestem dominates the areas native grasses. Ragweed, sunflower and stinging nettles provide ground cover.

Aquatic vegetation is lacking from this section of the Arkansas River. Aquatic surveys conducted by the Kansas Forestry, Fish and Game Commission (1977c) in this portion of the Arkansas River revealed back swimmers (family Notonectidae) were abundant while mussels were absent in the river. Angling is excellent for channel catfish in the area. Occasionally flathead catfish are also taken. Other sportfish or marketable species present include largemouth bass, black bullheads, green sunfish, bluegill, orangespotted sunfish, white crappie, carp and river carpsucker. Gizzard shad, sand shiners, golden redhorses and plains killifish comprise the forage component of the area's fish fauna.

Lower Arkansas River Basin. Once the Proposed Action crosses the Arkansas River it would enter the Lower Arkansas River Basin.

The Proposed Action would traverse Rattlesnake Creek at MP 551 in Stafford County. Near the proposed crossing the width of Rattlesnake Creek ranges between 10 and 30 feet and the mean depth is 8.2 inches. The streambed is composed of sand overlaid with silt and decaying organic material. The banks range from severe and undercut to gently sloping. The overstory partially shades the creek. The understory consists primarily of salt and alkali grass pasture. Arrowhead and water primrose are present.

Angling for channel catfish can be excellent at atimes in Rattlesnake Creek (Kansas Fish and Game Commission 1978). Other game fish or marketable species present near the proposed crossing include largemouth bass, flathead catfish, black crappie, green sunfish, orangespotted sunfish, black bullheads, river carpsucker, carp, and goldfish. A substantial population of Arkansas darters is located in this section of Rattlesnake Creek. Other forage fishes present are red shiners and mosquitofish.

Peace Creek would be crossed by the Proposed Action at MP 558 in Stafford County. A stream width range from 10 to 23 feet and an average depth of 18 inches are characteristic of Peace Creek near the proposed crossing. The streambed is silty and the banks low. Extensive cultivation on both sides of Peace Creek confines the riparian vegetation to narrow areas. Cottonwoods, sunflowers and little ragweed occur sparsely along the stream banks (Kansas Fish and Game Commission 1978). Aquatic vegetation is lacking in this section of Peace Creek.

Mayflies, damselflies and dragonflies are common components of the benthic fauna. Increased turbidities resulting from the extensive agricultural development in the Peace Creek sub-basin limits angling potential. Channel catfish, black bullheads, carp and drum are the most frequently angled species. Green sunfish, river carpsucker, mosquitofish, red shiners, sand shiners, bluntnose minnows and suckermouth minnows are also present.

Near the proposed crossing of the Chikaskia River at MP 610 in Kingman County, the river averages 56 feet in width and 9.4 inches in depth (Kansas Fish and Game Commission 1978). A shale outcropping in this section of the river forms a natural dam and fish concentration area. The streambed is primarily sand and the banks undercut and overhung with willow. Fish present in the area which would be traversed include largemouth bass, channel catfish, yellow bullheads, green sunfish, bluegills, white crappie, river carpsucker, golden redhorses, suckermouth minnows, bluntface shiners, red shiners, sand shiners, fathead minnows, stonerollers, plains killifish, mosquitofish and orangethroat darters.

Sand Creek would be traversed by the Proposed Action at MP 628. The areas primary vegetation is native grassland with a willow, ash and elm overstory. Sedges are common along the shore. The streambed consists of sand and small pebbles. Dragonflies, mayflies and damselflies are probably common. From a fishery standpoint, this section of Sand Creek is highly productive although angler use is low (Kansas Fish and Game Commission 1978). Sport fish and marketable species present include largemouth bass, green sunfish, yellow bullheads, bluegill, and golden redhorses. Nonsport fish present include stonerollers, sand shiners, plains killifish, red shiners, mosquitofish, and bullhead minnows.

The final stream which would be traversed by the Proposed Action in Kansas is Bluff Creek (MP 649). At the proposed crossing this creek averages 39 feet in width and 13.2 inches in depth. Generally, the stream flows between steep mud banks over a silt bottom. The Kansas Fish and Game Commission (1978) collected the following unionid mussels from Bluff Creek near the Proposed Action crossing:

maple-leaf mussel (*Quadrula quadrula*)
pimple-backed mussel (*Quadrula pustulosa*)
paper shell mussel (*Leptodea lavissima*)
yellow sand shell mussel (*Lampsilis anodontoides*)
buck horn mussel (*Tritogonia verrucosa*)
blue-point mussel (*Credonta p. peruviana*)
common pond mussel (*Ligumia subrostrata*)
pond horn mussel (*Uniomerus tetralasmus*)
fat mucket mussel (*Lampsilis radiata*)

Sport fish and marketable species present in this section of Bluff Creek are spotted bass, channel catfish, flathead catfish, green sunfish, orangespotted sunfish, lonear sunfish, white crappie, longnose gar, carp, river carpsucker, drum, golden redhorses and shorthead redhorses (Kansas Fish and Game Commission 1978). Suckermouth minnows, red and sand shiners, stonerollers, mosquitofish, orangethroat darters and slenderhead darters comprise the forage portion of the Bluff Creek fish fauna.

## Oklahoma

A list of streams and rivers which would be crossed by the Proposed Action through Oklahoma appears on Table 30. Fishes which could occur in those streams are listed in Table 31.

Oklahoma has no natural lakes to speak of (Lambou et al. 1965). This once arid state, through the construction of flood control, water supply and hydro-electric reservoirs, presently has in excess of 1,300,000 surface acres of water (Lambou et al. 1965). During normal water years, streams in Oklahoma account for approximately 100,000 surface acres of water. Many of the state's streams furnish very limited sport fishing because of siltation, domestic and industrial pollution, and lowering water tables. The eastern third of the state contains the majority of fishable streams and creeks.

Oklahoma waters drain into two major river systems; the Arkansas River system in roughly the northern two thirds of the state and the Red River system in about the southern third (Miller and Robison 1973).

Four distinct biotic districts are represented in northeastern Oklahoma (Blair and Hubbell 1938 and Webb 1970). The Proposed Action would enter the state in mixed-grass plains; a rolling grassland with trees occurring along some of the larger streams. Streams in the plains area are moderately clear to turbid in nature with scattered stands of *Justicia americana* and *Jussiaea repens*. Streams which would be traversed by the Proposed Action in this biotic district include the Salt Fork Arkansas River (MP 687.5) and Red Rock Creek (MP 698).

East of the mixed-grass plains is Osage Savannah; the hilly terrain is, for the most part, covered with oak and hickory. The principal streams in the western Osage Savannah are the headwaters of Caney River (MP 772). The lower reaches of the Neosho and Illinois Rivers are in

Table 30 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION THROUGH OKLAHOMA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Bluff Creek | 651.5 | I | Grant |
| UT Bluff Creek | 653 | I | Grant |
| Thompson Creek | 671 | I | Kay |
| UT Stink Creek | 674 | I | Kay |
| UT Stink Creek | 676 | I | Kay |
| Chikaskia River[2] | 684 | P | Kay |
| Chikaskia River | 684.5 | P | Kay |
| Salt Fork Arkansas River[2] | 687 | P | Kay |
| Birds Nest Creek | 688.5 | I | Noble |
| UT Red Rock Creek | 696 | I | Noble |
| Red Rock Creek | 698 | P | Noble |
| UT Red Rock Creek | 699.5 | I | Noble |
| Greasy Creek | 704 | I | Pawnee |
| Greasy Creek | 704.5 | I | Pawnee |
| UT Greasy Creek | 706.5 | I | Pawnee |
| Rock Creek | 708.5 | I | Pawnee |
| Walker Creek | 710.5 | I | Pawnee |
| UT Coal Creek | 715 | I | Pawnee |
| UT Coal Creek | 717 | I | Pawnee |
| Coon Creek | 719.5 | I | Pawnee |
| Arkansas River[2] | 720 | P | Osage |
| UT Arkansas River | 721 | I | Osage |
| UT Arkansas River | 723 | I | Osage |
| UT Arkansas River | 724 | I | Osage |
| UT Arkansas River | 725 | I | Osage |
| UT Sycamore Creek | 726 | I | Osage |
| UT Sycamore Creek | 726.5 | I | Osage |
| Sycamore Creek | 727 | P | Osage |
| Bug Creek | 730.5 | P | Osage |
| UT Bug Creek | 732 | I | Osage |
| Penn Creek | 734.5 | I | Osage |
| UT Penn Creek | 737.5 | I | Osage |
| Hominy Creek | 740.5 | P | Osage |
| Mahala Creek | 741.5 | I | Osage |
| Sunset Creek | 742 | I | Osage |
| Sand Creek | 745 | I | Osage |
| UT Bull Creek | 746.5 | I | Osage |
| Bull Creek | 748.5 | I | Osage |
| UT Bull Creek | 749.5 | I | Osage |
| UT Bull Creek | 754 | I | Osage |
| UT Quapaw | 758 | I | Osage |
| Candy Creek | 760.5 | P | Osage |
| UT Candy Creek | 761.5 | I | Washington |
| Bird Creek | 763 | I | Washington |

Table 30. (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Caney River | 768.5 | I | Washington |
| Caney River | 772 | P | Rogers |
| Rabb Creek | 772.5 | I | Rogers |
| UT Rabb Creek | 775 | P | Rogers |
| Fourmile Creek | 777.5 | P | Rogers |
| Verdigris River[2] | 779 | P | Rogers |
| Dog Creek | 789.5 | P | Rogers |
| UT Lake Claremore | 791 | I | Rogers |
| UT Chouteau Creek | 796 | I | Rogers |
| UT Chouteau Creek | 803 | I | Mayes |
| UT Chouteau Creek | 806 | I | Mayes |
| Chouteau Creek | 810.5 | P | Mayes |
| Brush Creek | 812 | P | Mayes |
| UT Brush Creek | 812.5 | I | Mayes |
| UT Brush Creek | 814 | I | Mayes |
| Flat Rock Creek | 819 | P | Wagoner |
| UT Fort Gibson Reservoir | 827.5 | P | Wagoner |
| UT Arkansas River | 832 | I | Wagoner |
| Neosho River[1] | 838 | P | Muskogee |
| Arkansas River | 843 | P | Muskogee |
| Coody Creek | 843.5 | P | Muskogee |
| UT Coody Creek | 845 | P | Muskogee |
| UT Arkansas River | 847 | P | Muskogee |
| Spaniard Creek[1] | 853 | P | Muskogee |
| UT Arkansas River | 857 | P | Muskogee |
| UT Dirty Creek | 858 | I | Muskogee |
| UT Dirty Creek | 859 | I | Muskogee |
| Arkansas River[1] | 865 | P | Muskogee |
| Illinois River | 865.5 | P | Sequoyah |
| UT Arkansas River | 870 | I | Sequoyah |
| Vian Creek | 871.5 | P | Sequoyah |
| Little Vian Creek | 874.5 | P | Sequoyah |
| UT Little Sallisaw Creek | 878 | I | Sequoyah |
| Sallisaw Creek | 880 | P | Sequoyah |
| Hog Creek | 884 | P | Sequoyah |
| UT Hog Creek | 885.5 | P | Sequoyah |
| Little Sallisaw Creek | 888 | P | Sequoyah |
| UT Little Sallisaw Creek | 889.5 | I | Sequoyah |
| UT Little Sallisaw Creek | 890 | I | Sequoyah |
| Big Skin Bayou | 892.5 | P | Sequoyah |

Table 31 FISHES WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION THROUGH OKLAHOMA (DISTRIBUTION DATA FROM MILLER AND ROBISON 1973)

| | |
|---|---|
| FAMILY PETROMYZONTIDAE | LAMPREYS |
| Ichthyomyzon castaneus | Chestnut lamprey |
| Ichthyomyzon gagei | Southern brook lamprey |
| FAMILY POLYODONTIDAE | PADDLEFISHES |
| Polyodon spathula | Paddlefish |
| FAMILY LEPISOSTEIDAE | GARS |
| Lepisosteus oculatus | Spotted gar |
| Lepisosteus osseus | Longnose gar |
| Lepisosteus platostomus | Shortnose gar |
| FAMILY ANGUILLIDAE | FRESHWATER EELS |
| Anguilla rostrata | American eel |
| FAMILY CLUPEIDAE | HERRINGS |
| Alosa chrysochloris | Skipjack herring |
| Dorosoma cepedianum | Gizzard shad |
| Dorosoma petenense | Threadfin shad |
| FAMILY HIODONTIDAE | MOONEYES |
| Hiodon alosoides | Goldeye |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| Campostoma anomalum | Stoneroller |
| Cyprinus auratus | Goldfish |
| Cyprinus carpio | Carp |
| Dionda nubila | Ozark minnow |
| Hybognathus nuchalis | Silvery chub |
| Hybognathus placitus | Plains minnow |
| Hybopsis aestivalis | Speckled chub |
| Hybopsis amblops | Bigeye chub |
| Hybopsis storeriana | Silver chub |
| Hybopsis x-punctata | Gravel chub |
| Nocomis asper | Redspot chub |
| Notemigonus crysoleucas | Golden shiner |
| Notropis amnis | Pallid shiner |
| Notropis atherinoides | Emerald shiner |
| Notropis blennius | River shiner |
| Notropis boops | Bigeye shiner |
| Notropis buchanani | Ghost shiner |
| Notropis camurus | Bluntface shiner |
| Notropis cornutus | Common shiner |
| Notropis fumeus | Ribbon shiner |
| Notropis girardi | Arkansas River shiner |
| Notropis greenei | Wedgespot shiner |
| Notropis lutrensis | Red shiner |

| | |
|---|---|
| FAMILY CYPRINIDAE (Continued) | MINNOWS AND CARPS (Continued) |
| Notropis ortenburgeri | Kiamichi shiner |
| Notropis pilsbryi | Duskystripe shiner |
| Notropis rubellus | Rosyface shiner |
| Notropis shumardi | Silverband shiner |
| Notropis spilopterus | Spotfin shiner |
| Notropis stramineus | Sand shiner |
| Notropis umbratilis | Redfin shiner |
| Notropis volucellus | Mimic shiner |
| Notropis whipplei | Steelcolor shiner |
| Phenacobius mirabilis | Suckermouth minnow |
| Phoxinus erythrogaster | Southern redbelly dace |
| Pimephales notatus | Bluntnose minnow |
| Pimephales promelas | Fathead minnow |
| Pimephales tenellus | Slim minnow |
| Pimephales vigilax | Bullhead minnow |
| Semotilus atromaculatus | Creek chub |
| FAMILY CATOSTOMIDAE | SUCKERS |
| Carpiodes carpio | River carpsucker |
| Carpiodes velifer | Highfin carpsucker |
| Catostomus commersani | White sucker |
| Erimyzon oblongus | Creek chubsucker |
| Hypentelium nigricans | Northern hog sucker |
| Ictiobus bubalus | Smallmouth buffalo |
| Ictiobus cyprinellus | Bigmouth buffalo |
| Ictiobus niger | Black buffalo |
| Minytrema elanops | Spotted sucker |
| Moxostoma carinatum | River redhorse |
| Moxostoma duquesnei | Black redhorse |
| Moxostoma erythrurum | Golden redhorse |
| Moxostoma macrolepidotum | Shorthead redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| Ictalurus furcatus | Blue catfish |
| Ictalurus melas | Black bullhead |
| Ictalurus natalis | Yellow bullhead |
| Ictalurus punctatus | Channel catfish |
| Noturus exilis | Slender madtom |
| Noturus flavus | Stonecat |
| Noturus miurus[a] | Brindled madtom |
| Noturus nocturnus | Freckled mandtom |
| Noturus placidus | Neosho madtom |
| Pylodictis olivaris | Flathead catfish |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| Fundulus kansae | Plains killifish |
| Fundulus notatus | Blackstripe topminnow |
| Fundulus olivaceus | Blackspotted topminnow |

| | |
|---|---|
| FAMILY POECILIIDAE | LIVEBEARERS |
| Gambusia affinis | Mosquitofish |
| FAMILY ATHERINIDAE | SILVERSIDES |
| Labidesthes sicculus | Brook silverside |
| FAMILY COTTIDAE | SCULPINS |
| Cottus carolinae | Banded sculpin |
| FAMILY PERCICHTHYIDAE | TEMPERATE BASSES |
| Morone chrysops | White bass |
| Morone saxatilis | Striped bass |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| Ambloplites rupestris | Rock bass |
| Lepomis gulosus | Warmouth |
| Lepomis cyanellus | Green sunfish |
| Lepomis humilis | Orangespotted sunfish |
| Lepomis macrochirus | Bluegill |
| Lepomis megalotis | Longear sunfish |
| Lepomis microlophus | Redear sunfish |
| Micropterus dolomieui | Smallmouth bass |
| Micropterus punctulatus | Spotted bass |
| Micropeterus salmoides | Largemouth bass |
| Pomoxis annularis | White crappie |
| Pomoxis nigromaculatus | Black crappie |
| FAMILY PERCIDAE | PERCHES |
| Etheostoma blennioides | Greenside darter |
| Etheostoma chlorosomum | Bluntnose darter |
| Etheostoma flabellare | Fantail darter |
| Etheostoma gracile | Slough darter |
| Etheostoma microperca | Least darter |
| Etheostoma proeliare | Cypress darter |
| Etheostoma punctulatum | Stippled darter |
| Etheostoma spectabile | Orangethroat darter |
| Etheostoma stigmaeum | Speckled darter |
| Etheostoma whipplei | Redfin darter |
| Etheostoma zonale | Banded darter |
| Perca flavescens | Yellow perch |
| Percina caprodes | Logperch |
| Percina copelandi | Channel darter |
| Percina maculata | Blackside darter |
| Percina nasuta | Longnose darter |
| Percina phoxocephala | Slenderhead darter |
| Percina sciera | Dusky darter |
| Percina shumardi | River darter |
| Stizostedion canadense | Sauger |
| Stizostedion vitreum | Walleye |
| FAMILY SCIAENIDAE | DRUMS |
| Aplodinotus grunniens | Drum |

a = Threatened: Deacon et al. 1979.

the Osage Savannah biotic district. Most of the streams have boulder-strewn, rapid headwaters followed by riffle and pool stretches which eventually give way to deeply entrenched meandering lower reaches of low velocity. These streams vary from clear to turbid; those coming from the Ozark biotic district are very clear. A few of the Osage district streams are sufficiently clear to have submerged vegetation such as Myriophyllum. The majority of the streams in this district, however, lack submerged vegetation although they may be abundantly supplied with Justicia americana and Jussiaea repens.

Between the two segments of the Osage Savannah lies the Cherokee Prairie: rolling grassland where the soft Pennsylvanian shales have eroded leaving occasional hills, usually wooded, of sandstone or limestone. Streams are mostly sluggish, turbid, without submerged vegetation, but abundantly supplied with Justicia americana and Jussiaea repens. Principal streams are Caney River, the Verdigris River and the western tributaries of Neosho River.

The eastern Oklahoma section of the Proposed Action is in the Ozark biotic district. Here a peneplain built on Mississippian limestone and chert has been dissected to form hills and valleys. Some Ordovician and Silurian strata, chiefly sandstones, are exposed along major streams. The principal streams are the Neosho River and its eastern tributaries, and the upper portion of the Illinois River system. Springs are abundant and brooks and creeks are usually crystal-clear, making possible abundant submerged vegetation such as Ceratophyllum, Myriophyllum, Potamogeton, Ranunculus, Elodea and Polygonum. Watercress, Nasturtium officinale, is abundant along brooks (Blair 1959).

A stream evaluation map for Oklahoma has been prepared by the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation (1978); a list of streams with high-valued fishery resources which would be traversed by the Proposed Action are listed in Table 32. Streams listed in Table 32 correspond to critical spawning

Table 32 OKLAHOMA STREAMS AND RIVERS, WITH VALUABLE FISHERY RESOURCES, WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION (U.S. FISH AND WILDLIFE SERVICE AND OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION 1978)

| Stream | MP at Crossing | Classification* |
|---|---|---|
| Chikaskia River | 684 | Class I |
| Chikaskia River | 684.5 | Class I |
| Salt Fork Arkansas River | 687 | Class I |
| Red Rock Creek | 698 | Class II |
| Arkansas River | 720 | Class I |
| Sycamore Creek | 727 | Class I |
| Bug Creek | 730.5 | Class I |
| Hominy Creek | 740.5 | Class I |
| Bull Creek | 748.5 | Class I |
| Bird Creek | 763 | Class I |
| Caney River | 772 | Class II |
| Fourmile Creek | 777.5 | Class II |
| Verdigris River | 779 | Class I |
| Dog Creek | 789.5 | Class II |
| Chouteau Creek | 810.5 | Class II |
| Brush Creek | 812 | Class II |
| Neosho River | 838 | Class I |
| Arkansas River | 843 | Class I |
| Coody Creek | 843.5 | Class II |
| Vian Creek | 871.5 | Class II |
| Little Vian Creek | 874.5 | Class II |
| Salisaw Creek | 880 | Class I |
| Little Salisaw Creek | 888 | Class II |
| Big Skin Bayou | 892.5 | Class I |

* Class I waters - highest-valued fishery resource.
Class II waters - high-priority fishery resource.

habitats utilized by striped and white bass from large Oklahoma reservoirs. Striped and white bass spawning in Oklahoma is discussed later in this section. Most of the rivers listed in Table 32 also provide excellent catfish and sunfish fishing.

From west to east the Proposed Action would traverse the Arkansas, Verdigris and Neosho River basins. After leaving the Neosho River basin, the Proposed Action would reenter the Arkansas River basin and continue through it into Arkansas.

Intermittent Oklahoma streams usually support a variety of tolerant fish species, and depending upon the individual stream characteristics, are typically dominated by golden shiners, fathead minnows, black bullheads, bluegill and green sunfish (Harrel et al. 1967). Other, less abundant fishes include orangespotted sunfish, mosquitofish, red shiner, longear sunfish, largemouth bass, white crappie, channel catfish, yellow bullheads, river carpsucker and gizzard shad.

Reimer (1967), during a survey of Oklahoma crayfish, found the following species common in northeastern Oklahoma:

*Orconectes palmeri longimanus*
*Procambarus gracilis*
*Orconectes neglectus neglectus*
*Orconectes nais*
*Orconectes causeyi*
*Orconectes nana nana*
*Orconectes meeki breuis*
*Procambarus simulans simulans*

These species may occur in streams and rivers which would be traversed by the Proposed Action through Oklahoma.

Eastern tributaries to the Chikaskia River, in northeastern Oklahoma, would be traversed at MP 671 and 676 by the Proposed Action. Both tributaries which would be crossed are intermittent (Table 30).

The Chikaskia River would be traversed at MP 684 and 684.5 by the Proposed Action. The Chikaskia River system arises from springs and seeps in the southern part of Pratt County, Kansas and drains approximately 2050 square miles of the Great Plains. The average stream gradient in the Chikaskia River is 5.4 feet/mile (Moore and Buck 1953). The rivers topography is characterized by treeless plains and gently undulating prairie and agriculture bisected by wooded streams. The Oklahoma portion is 50-75 feet wide and the substrate is composed of sand, gravel, rocks, shale and soft mud. The banks are mostly soft and muddy.

According to Moore and Buck (1953) the eastern tributaries to the Chikaskia River usually have beds of *Scirpus* and *Jussiaea*. These tributaries are usually between 6 and 7 feet wide with a maximum depth of about 2 feet. The riffles flow over sand and gravel and some *Spirogyra* is present.

Orangespotted sunfish, green sunfish, black bullheads and bullhead minnows are common in these intermittent tributaries. Fishes including sand shiners and bluntnose minnows, which are widespread in eastern Oklahoma, may also be present (Miller and Robison 1973).

Hominy Creek would be traversed by the Proposed Action in Oklahoma at MP 740.5 in Osage County. Hominy Creek is a tributary of Bird Creek at river mile 27.4. The creek flows southeasterly through an isolated, rural setting for approximately 72 miles to its confluence with Bird Creek. The upper reach of Hominy Creek flows through a well defined canyon and has numerous riffles and pool areas. In the lower reach, the creek meanders are deeply entrenched in the floodplain. A dam across Hominy Creek at Skiatook creates Skiatook Lake which is downstream from the proposed crossing.

The main tributaries to Hominy Creek in the area are Tall Chief Creek, Turkey Creek, Gouin Creek, Bull Creek (MP 748.5), Wildhorse Creek, Boar Creek, Sand Creek (MP 745) and Mahala Creek (MP 741.5 ; U.S. Army Corps of Engineers 1972).

The stream gradient in Hominy Creek ranges from 3 feet/mile at the Skiatook Dam site to more than 100 feet per mile on some of the upstream tributaries. The creek is subject to extreme flucutations of flow, overflowing its channel during periods of heavy precipitation, but often having zero discharge during periods of drought. Streamflow extremes range from zero to approximately 36,000 cfs (U.S. Army Corps of Engineers 1972).

Possible sources of pollution presently affecting the Hominy Creek basin upstream of the Skiatook Dam include: nine operational oil fields; the municipal waste treatment facilities (secondary treatment) at Hominy, Oklahoma; one privately owned waste disposal site near Hominy; and one active feedlot operation near Hominy (Gries et al. 1972).

The area surrounding Hominy Creek was described by the U.S. Army Corps of Engineers (1972) as being distinguished primarily by sandy soils and sandstone capped hills whose tops and upper slopes are forested with post oak, blackjack oak, black oak and chinquapin oak, with bur oak, bitternut hickory, shagback hickory, American elm, slippery elm and hackberry becoming mixed with the above species on the lower slopes and along the stream.

The Hominy Creek basin is wooded along the stream banks and for varying distances over land which is subject to overflow. Hominy Creek and its tributaries have eroded through the sandstone of the uplands and have formed deep valleys except in the vicinity of the dam site and lower floodplain where the valley is relatively wide and flat. Since settlement of the area, the more productive soils of the valleys of Hominy Creek and its major tributaries have been planted in diversified agricultural crops. Consequently, much of the basin's riparian habitat is restricted to narrowed areas.

The most important sportfishes in Hominy Creek are channel catfish, crappie, largemouth bass, spotted bass and other centrarchids (sunfishes;

Table 33). Wallen (1958) and others have collected 48 species of fish from Hominy Creek and its tributaries (Table 33). Miller (1972) considered the slenderhead darter (Percina phoxocephala) as rare in Oklahoma, however, Jenkins and Finnell (1957) found it common in the Verdigris River system. In a review of endangered and rare fishes in Oklahoma, Robison and others (1975) did not list the slenderhead darter as either endangered or rare.

Benthic invertebrates were collected from Hominy Creek by the U.S. Army Corps of Engineers (1972) in the headwaters and mainstream prior to the construction of Skiatook Lake. The results of their collections appear in the species list presented in Table 34.

In the creek above Skiatook Lake, blackfly larvae are the most abundant riffle organisms. Also common in the riffles are larval stages of mayflies, caddisflies, and midges. Isopods also are found on rocks in the riffle areas. Common inhabitants of the pools are midge larvae and aquatic annelids. Bryozoans are common on rocks in the slower moving areas of the stream. Near Skiatook Lake mayfly nymphs are the most abundant organisms in the riffles. Blackfly larvae and caddisfly larvae are present but not abundant. Also present in the riffles are larvae of stoneflies and alderflies. In samples from pools the Corps of Engineers found only midge larvae and in very few numbers. Freshwater clams are common in Hominy Creek.

In the creek below Skiatook Dam, larval stages of caddisflies and mayflies are the most common inhabitants of riffle areas. Riffle beetles also are present in lesser abundance. Blackfly larvae are present but in low numbers. Aquatic annelids are the most abundant organisms in pools.

Other aquatic invertebrates which probably are located in Hominy Creek and its tributaries include biting midges, mosquitoes, horseflies, craneflies and crayfish.

Table 33 FISHES OF HOMINY CREEK, OKLAHOMA (U.S. ARMY CORPS OF ENGINEERS 1972)

| Scientific Name | Common Name |
|---|---|
| FAMILY LEPISOSTEIDAE | GARS |
| *Lepisosteus platosotomus* | Shortnose gar |
| *L. oculatus* | Spotted gar |
| FAMILY CLUPEIDAE | HERRINGS |
| *Dorosoma cepedianum* | Gizzard shad |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Notemigonus crysoleucas* | Golden shiner |
| *Hybopsis storeriana* | Silver chub |
| *Notropis umbratilis* | Redfin shiner |
| *N. camurus* | Bluntface shiner |
| *N. lutrensis* | Red shiner |
| *N. stramineus* | Sand shiner |
| *N. volucellus* | Mimic shiner |
| *N. buchanani* | Ghost shiner |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Pimephales promelas* | Fathead minnow |
| *P. notatus* | Bluntnose minnow |
| *P. vigilax* | Bullhead minnow |
| *P. tenellus* | Slim minnow |
| *Campostoma anomalum* | Stoneroller |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Moxostoma erythrurum* | Golden redhorse |
| *M. macrolepidotum* | Shorthead redhorse |
| *M. duquesnei* | Black redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus punctatus* | Channel catfish |
| *I. melas* | Black bullhead |
| *I. natalis* | Yellow bullhead |
| *Pylodictus olivaris* | Flathead catfish |
| *Noturus flavus* | Stonecat |
| *N. nocturnus* | Freckled madton |
| FAMILY CYPRINODONTIDAE | TOPMINNOWS |
| *Fundulus notatus* | Blackstripe topminnow |
| *F. kansae* | Plains killifish |
| Poeciliidae | MOSQUITOFISHES |
| *Gambusia affinis* | Mosquitofish |

Table 33 (concluded)

| Scientific Name | Common Name |
|---|---|
| Atherinidae | SILVERSIDES |
| *Labidesthes sicculus* | Brook silverside |
| Serranidae | TEMPERATE BASSES |
| *Morone chrysops* | White bass |
| Centrarchidae | SUNFISHES |
| *Micropterus punctulatus* | Spotted bass |
| *M. salmoides* | Largemouth bass |
| *Lepomis gulosus* | Warmouth |
| *L. cyanellus* | Green sunfish |
| *L. microlophus* | Redear sunfish |
| *L. megalotis* | Longear sunfish |
| *L. humilis* | Orangespotted sunfish |
| *L. macrochirus* | Bluegill |
| *Pomoxis annularis* | White crappie |
| *P. nigromaculatus* | Black crappie |
| Percidae | PERCHES |
| *Percina phoxocephala* | Slenderhead darter |
| *P. copelandi* | Channel darter |
| *P. caprodes* | Logperch |
| *Etheostoma whipplei* | Redfin darter |
| *E. spectabile* | Orangethroat darter |
| Sciaenidae | DRUMS |
| *Aplodinotus grunniens* | Drum |

Table 34 BENTHIC MACROINVERTEBRATES OF HOMINY CREEK, OKLAHOMA (U.S. ARMY CORPS OF ENGINEERS 1972)

| TAXA |
| --- |
| Phylum Bryozoa |
| Class Oligochaeta |
| *Limnodrilus* sp. |
| *Branchiura sowerbyi* |
| Order Isopoda |
| *Lirceus* sp. |
| Class Insecta |
| *Stenonema* sp. |
| *Siphlonurus* sp. |
| *Progomphus* sp. |
| *Isoperla* sp. |
| *Sialis* sp. |
| *Stenelmis* sp. |
| *Smicridea* sp. |
| *Chimarra* sp. |
| *Simulium* sp. |
| Tendipedidae |
| Phylum Mollusca |
| *Sphaerium* sp. |
| Unionidae |

The aquatic fauna in many areas of Hominy Creek is limited by intermittent flows to species such as caddisfly larvae capable of aestivation; species such as blackflies which have a short aquatic stage in their life cycle; and to relatively mobile species such as fishes capable of invading these areas soon after streamflows begin (U.S. Army Corps of Engineers 1972).

The Verdigris River would be crossed by the Proposed Action at MP 779 just below Oologah Lake. The river is moderately to extremely turbid during high flows (U.S. Army Corps of Engineers 1975a). Considerable mud and silt occurs in the tributaries, with the mainstream of the river being gravel or rock bottom. Consequently, Oologah Lake is often muddy due to turbidity from the mainstream and to wind and wave action within the lake. The lake, at conservation pool level, has 29,500 surface acres. The Verdigris River downstream from the dam provides a fishery of moderate value because of the improved stream conditions resulting from releases. When discharges at Oologah Lake are made at the rate of 3,000 cfs or less, all of the water remains within the banks of the Verdigris River and no downstream lowlands are flooded.

The portion of the Verdigris River which would be crossed lies in the southernmost tip of the Cherokee Prairie biotic district. To the east is the Ozark biotic district, and to the west is the Osage Savannah biotic district. The region surrounding the Verdigris River has characteristics of a transitional zone. The vegetation is primarily composed of two major types: post oak-blackjack oak and bottomland hardwood. Past agricultural and construction activities have greatly reduced the amount of bottomland hardwood forest in the basin. The overstory is largely composed of post oak, blackjack oak, eastern red cedar, and black hickory. The understory consists of broomsedge, big bluestem, little bluestem, coral berry, winged sumac, smooth sumac, blackberry, black raspberry, and dewberry.

Fishes collected by Jenkins and Finnell (1957) from the Verdigris River system in Oklahoma are listed in Table 35.

Table 35 FISHES OF THE VERDIGRIS RIVER SYSTEM, OKLAHOMA (JENKINS AND FINNELL 1957)

| Scientific Name | Common Name |
|---|---|
| FAMILY LEPISOSTEIDAE | GARS |
| *Lepisosteus oculatus* | Spotted gar |
| *Lepisosteus osseus* | Longnose gar |
| *Lepisosteus platostomus* | Shortnose gar |
| *Lepisosteus spathula* | Alligator gar |
| FAMILY POLYODONTIDAE | PADDLEFISHES |
| *Polyodon spathula* | Paddlefish |
| FAMILY CLUPEIDAE | HERRINGS |
| *Alosa chrysochloris* | Skipjack herring |
| *Dorosoma cepedianum* | Gizzard shad |
| FAMILY HIODONTIDAE | MOONEYES |
| *Hiodon alosoides* | Goldeye |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Notemigonus crysoleucas* | Golden shiner |
| *Notropis umbratilis* | Redfin shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis volucellus* | Mimic shiner |
| *Notropis buchanani* | Ghost shiner |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Hybognathus nuchalis* | Silvery minnow |
| *Pimephales promelas* | Fathead minnow |
| *Pimephales notatus* | Bluntnose minnow |
| *Pimephales tenellus* | Slim minnow |
| *Campostoma anomalum* | Stoneroller |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Moxostoma erythrurum* | Golden redhorse |
| *Minytrema melanops* | Spotted sucker |
| *Carpiodes carpio* | River carpsucker |
| *Ictiobus niger* | Black buffalo |
| *Ictiobus cyprinellus* | Bigmouth buffalo |
| *Ictiobus bubalus* | Smallmouth buffalo |
| *Carpiodes velifer* | Highfin carpsucker |
| *Cycleptus elongatus* | Blue sucker |

Table 35 (continued)

| Scientific Name | Common Name |
|---|---|
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus punctatus* | Channel catfish |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus natalis* | Yellow bullhead |
| *Pylodictis olivaris* | Flathead catfish |
| *Noturus flavus* | Stonecat |
| *Noturus miurus* | Brindled madtom |
| FAMILY ANGUILLIDAE | FRESHWATER EELS |
| *Anguilla rostrata* | American eel |
| FAMILY CYPRINODONTIDAE | TOPMINNOWS |
| *Fundulus notatus* | Blackstripe topminnow |
| FAMILY POECILIIDAE | LIVEBEARERS |
| *Gambusia affinis* | Mosquitofish |
| FAMILY ATHERINIDAE | SILVERSIDES |
| *Labidesthes sicculus* | Brook silverside |
| FAMILY PERCICHTHYIDAE | TEMPERATE BASSES |
| *Morone chrysops* | White bass |
| *Morone saxatilis* | Striped bass |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Micropterus salmoides* | Largemouth bass |
| *Micropterus punctulatus* | Spotted bass |
| *Lepomis gulosus* | Warmouth |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis megalotis* | Longear sunfish |
| *Lepomis humilis* | Orangespotted sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Pomoxis annularis* | White crappie |
| *Pomoxis nigromaculatus* | Black crappie |
| FAMILY PERCIDAE | PERCHES |
| *Percina maculata* | Blackside darter |
| *Percina phoxocephala* | Slenderhead darter |
| *Percina copelandi* | Channel darter |
| *Percina caprodes* | Logperch |
| *Etheostoma gracile* | Slough darter |
| *Stizostedion canadense* | Sauger |

Table 35 (concluded)

| Scientific Name | Common Name |
|---|---|
| FAMILY SCIAENIDAE | DRUMS |
| *Aplodinotus grunniens* | Drum |

The Proposed Action would run directly west of Fort Gibson Reservoir between MP 810 and 836 in Mayes and Wagoner counties. At conservation pool level there are 19,900 surface acres of potential aquatic habitat in Fort Gibson Reservoir (University of Tulsa 1977). Some of the feeder streams to Fort Gibson Reservoir flow the year-round. Most feeder streams which would be crossed on the western shore, arise in the Cherokee Prairie and Osage Savannah biotic districts (Blair and Hubbell 1938) and become intermittent in the summer months. The flood pool level is reached only sporadically and for relatively brief periods of time.

Aquatic vegetation is not common in Fort Gibson Reservoir primarily because of wave action and the high turbidity of the lake waters. The frequent and strong winds also prevent the development of a floating flora. The cyclic high and low water flows associated with power generation at the Markham Ferry facility upstream have prevented aquatic vegetation from being established in the Neosho River between the Lake Hudson dam and the upper reaches of Fort Gibson Reservoir.

Gravel bars in portions of Fort Gibson Reservoir are annually colonized by black willow, green ash and other water tolerant species. Similar gravel bar habitats exist along the river between the Fort Gibson Dam and the junction of the Neosho with the Arkansas River. Management of the lake level results in significant variation in water depth and velocity and, in turn, limits the establishment of herbaceous vegetation. Only deeply rooted woody plants and firmly rooted herbaceous species like willow and ash can survive these environmental pressures.

Upstream portions of the Neosho and the beds of streams feeding the lake have deposits of alluvial soils that support typical bottomland vegetation. The steep slopes of the valleys on the east side prevent any large expanse of this vegetational type from developing, while the more gently sloping, western lakeside does support large areas of bottomland forest.

The feeder streams on the west side of Fort Gibson Reservoir differ significantly from those on the east. First, they are intermittent, often ceasing to flow completely during the summer, have a more gentle slope, and have silt loaded water of high turbidity (University of Tulsa 1977). As a result, most aquatic vegetation is found in the clear streams on the east, or Ozark uplift, side of the lake. Elodea Nuttallii (Nuttall's waterweed), Ceratophyllum demersum (hornwort), Lemna sp. (duckweed) and Potamogeton sp. (pondweed) are common. Many of the lake's backwater areas support Sagittaria spp. (arrowhead), Typha spp. (cattail), Alisma spp. (water plantain), as well as other emergents and submergents.

Hall (1952) provided a pre-impoundment list of fishes in the Fort Gibson Reservoir area, but since a large portion of the basin's fauna has been replaced by fishes better suited to the lacustrine environment, Hall's description is no longer appropriate. Surveys by Summers (1960), Miller and Robison (1973) and the University of Tulsa (1977) were used to develop the following discussion of the abundance and distribution of fishes near Fort Gibson Reservoir. The habitat preference of fishes known from the drainage are listed in Table 36.

Paddlefish are not common in Fort Gibson Reservoir although they are occasionally snagged by fishermen during the spring spawning run up the Neosho River below the Lake Hudson Dam. The longnose gar is the most common gar in the lake; the spotted and shortnose gar are more common in the tributaries.

The gizzard shad is the numerically dominant fish species in Fort Gibson Reservoir. As in all other Oklahoma impoundments, this fish has become the most important food source for the game fishes (University of Tulsa 1977). The threadfin shad probably occurs in the Fort Gibson basin and almost surely in the river below Fort Gibson Dam (University of Tulsa 1977). Its abundance in northeastern Oklahoma is restricted by its low tolerance for cold winters (Miller and Robison 1973). Carp, along with the river carpsucker is probably the most common rough fish

Table 36 HABITAT PREFERENCE OF FISHES WHICH COULD OCCUR IN THE PORTION OF THE FORT GIBSON RESERVOIR AREA WHICH WOULD BE TRAVERSED BY THE PROPOSED ACTION THROUGH OKLAHOMA (UNIVERSITY OF TULSA 1977, MILLER AND ROBISON 1973 and SUMMERS 1960)

| Scientific Name | Common Name | Habitat |
|---|---|---|
| FAMILY ACIPENSERIDAE | STURGEONS | |
| *Scaphirhynchus platorynchus* | Shovelnose sturgeon | 1) Neosho River below Ft. Gibson Dam 2) Neosho River upstream from Ft. Gibson Dam |
| FAMILY POLYODONTIDAE | PADDLEFISHES | |
| *Polyodon spathula* | Paddlefish | 1) Neosho River below Ft. Gibson Dam 2) Ft. Gibson Reservoir |
| FAMILY LEPISOSTEIDAE | GARS | |
| *Lepisosteus platostomus* | Shortnose gar | Ubiquitous |
| *Lepisosteus oculatus* | Spotted gar | Ubiquitous |
| *Lepisosteus osseus* | Longnose gar | Ubiquitous |
| FAMILY CLUPEIDAE | HERRINGS | |
| *Alosa chrysochloris* | Skipjack herring | Ubiquitous |
| *Dorosoma cepedianum* | Gizzard shad | Ubiquitous |
| *Dorosoma petenense* | Threadfin shad | Ubiquitous |
| FAMILY HIODONTIDAE | MOONEYES | |
| *Hiodon alosoides* | Goldeye | Ubiquitous |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS | |
| *Cyprinus carpio* | Carp | Ubiquitous |
| *Notemigonus crysoleucas* | Golden shiner | Ubiquitous |
| *Hybopsis storeriana* | Silver chub | Neosho River below Ft. Gibson Dam |
| *Hybopsis aestivalis* | Speckled dace | Neosho River below Ft. Gibson Dam |
| *Notropis atherinoides* | Emerald shiner | Ubiquitous |
| *Notropis rubellus* | Rosyface shiner | Ft. Gibson Reservoir |
| *Notropis umbratilis* | Redfin shiner | Ubiquitous |
| *Notropis blennius* | River shiner | 1) Neosho River below Ft. Gibson Dam 2) Ft. Gibson Reservoir |
| *Notropis greenei* | Wedgespot shiner | 1) Neosho River below Ft. Gibson Dam 2) Ft. Gibson Reservoir |

Table 36 (continued)

| Scientific Name | Common Name | Habitat |
|---|---|---|
| *Notropis whipplei* | Steelcolor shiner | 1) Neosho River below Ft. Gibson Dam<br>2) Ft. Gibson Reservoir |
| *Notropis camurus* | Bluntface shiner | Ubiquitous |
| *Notropis lutrensis* | Red shiner | Ubiquitous |
| *Notropis girardi* | Arkansas River shiner | 1) Neosho River below Ft. Gibson Dam<br>2) Neosho River above Ft. Gibson Reservoir |
| *Notropis boops* | Bigeye shiner | 1) Neosho River below Ft. Gibson Dam<br>2) Ft. Gibson Reservoir |
| *Notropis stramineus* | Sand shiner | Ubiquitous |
| *Notropis volucellus* | Mimic shiner | Ubiquitous |
| *Notropis buchanani* | Ghost shiner | Ubiquitous |
| *Phenacobius mirabilis* | Suckermouth minnow | Ubiquitous |
| *Hybognathus placitus* | Plains minnow | Ubiquitous |
| *Pimephales promelas* | Fathead minnow | Ubiquitous |
| *Pimephales notatus* | Bluntnose minnow | Ubiquitous |
| *Pimephales vigilax* | Bullhead minnow | Ubiquitous |
| *Pimephales tenellus* | Slim minnow | Ubiquitous |
| *Campostoma anomalum* | Stoneroller | Ubiquitous |
| FAMILY CATOSTOMIDAE | SUCKERS | |
| *Ictiobus cyprinellus* | Bigmouth buffalo | 1) Neosho River below Ft. Gibson Dam<br>2) Ft. Gibson Reservoir |
| *Ictiobus niger* | Black buffalo | --- |
| *Ictiobus bubalus* | Smallmouth buffalo | Ubiquitous |
| *Carpiodes carpio* | River carpsucker | Ubiquitous |
| *Carpiodes velifer* | Highfin carpsucker | 1) Neosho River below Ft. Gibson Dam<br>2) Ft. Gibson Reservoir |
| *Moxostoma erythrurum* | Golden redhorse | Ubiquitous |
| *Moxostoma macrolepidotum* | Shorthead redhorse | Ubiquitous |
| *Moxostoma carinatum* | River redhorse | Ubiquitous |
| *Moxostoma duguesnei* | Black redhorse | Ubiquitous |
| *Minytrema melanops* | Spotted sucker | Ubiquitous |
| FAMILY ICTALURIDAE | CATFISHES | |
| *Ictalurus furcatus* | Blue catfish | 1) Neosho River below Ft. Gibson Dam<br>2) Neosho River above Ft. Gibson Reservoir |

Table 36 (continued)

| Scientific Name | Common Name | Habitat |
|---|---|---|
| *Ictalurus punctatus* | Channel catfish | Ubiquitous |
| *Ictalurus melas* | Black bullhead | Ubiquitous |
| *Ictalurus natalis* | Yellow bullhead | Ubiquitous |
| *Pylodictis olivaris* | Flathead catfish | Ubiquitous |
| *Noturus flavus* | Stonecat | Ubiquitous |
| *Noturus nocturnus* | Freckled madtom | Ubiquitous |
| FAMILY ANGUILLIDAE | FRESHWATER EELS | |
| *Anguilla rostrata* | American eel | 1) Neosho River below Ft. Gibson Reservoir |
| FAMILY CYPRINODONTIDAE | TOPMINNOWS | |
| *Fundulus notatus* | Blackstripe topminnow | Ubiquitous |
| FAMILY POECILIIDAE | LIVEBEARERS | |
| *Gambusia affinis* | Mosquitofish | Ubiquitous |
| FAMILY ATHERINIDAE | SILVERSIDES | |
| *Labidesthes sicculus* | Brook silverside | Ubiquitous |
| *Menidia audens* | Mississippi silverside | 1) Neosho River below Ft. Gibson Reservoir 2) Ft. Gibson Reservoir |
| FAMILY PERCICHTHYIDAE | TEMPERATE BASSES | |
| *Morone chrysops* | White bass | Ubiquitous |
| *Morone saxatilis* | Striped bass | 1) Neosho River below Ft. Gibson Dam 2) Ft. Gibson Reservoir |
| FAMILY CENTRARCHIDAE | SUNFISHES | |
| *Micropterus punctulatus* | Spotted bass | Ubiquitous |
| *Micropterus dolomieui* | Smallmouth bass | Eastern Tributaries |
| *Micropterus salmoides* | Largemouth bass | Ubiquitous |
| *Lepomis gulosus* | Warmouth | Ubiquitous |
| *Lepomis cyanellus* | Green sunfish | Ubiquitous |
| *Lepomis microlophas* | Redear sunfish | Ubiquitous |
| *Lepomis megalotis* | Longear sunfish | Ubiquitous |
| *Lepomis humilis* | Orangespotted sunfish | Ubiquitous |
| *Lepomis macrochirus* | Bluegill | Ubiquitous |
| *Pomoxis annularis* | White crappie | Ubiquitous |
| *Pomoxis nigromaculatus* | Black crappie | Ubiquitous |

Table 36 (concluded)

| Scientific Name | Common Name | Habitat |
|---|---|---|
| FAMILY PERCIDAE | PERCHES | |
| *Stizostedion canadense* | Sauger | 1) Neosho River below Ft. Gibson Dam<br>2) Neosho River above Ft. Gibson Reservoir |
| *Stizostedion vitreum* | Walleye | 1) Neosho River below Ft. Gibson Dam<br>2) Neosho River above Ft. Gibson Reservoir |
| *Percina phoxocephala* | Slenderhead darter | 1) Western tributaries to Ft. Gibson Res.<br>2) Neosho River below Ft. Gibson Dam |
| *Percina copelandi* | Channel darter | Ubiquitous |
| *Percina caprodes* | Logperch | Ubiquitous |
| *Etheostoma chlorosomum* | Bluntnose darter | Western tributaries to Ft. Gibson Res. |
| *Etheostoma zonale* | Banded darter | Neosho River below Ft. Gibson Dam |
| *Etheostoma blennioides* | Greenside darter | Neosho River below Ft. Gibson Dam |
| *Etheostoma whipplei* | Redfin darter | Western tributaries to Ft. Gibson Res. |
| *Etheostoma spectabile* | Orangethroat darter | Ubiquitous |
| *Etheostoma gracile* | Slough darter | Western tributaries to Ft. Gibson Res. |
| FAMILY SCIAENIDAE | DRUMS | |
| *Aplodinotus grunniens* | Drums | Ubiquitous |

in Fort Gibson Reservoir. Red shiners are the most ubiquitous of Oklahoma minnows, reaching tremendous population densities, particularly in the western tributaries and in the reservoir.

The suckermouth minnow probably inhabits Flat Rock (MP 819) and Brush creeks (MP 812) and may even live in the Neosho River. It is an inhabitant of fast streams, occurring commonly where there are large flat rocks lying loose on the bedrock (University of Tulsa 1977). The plains minnow may be abundant in some parts of the lake. Before construction of dams along the Arkansas River it was one of the most, if not the most common fish in the Arkansas drainage, and this species was known to have a spring and summer migration up into the tributaries. The highfin carpsucker was considered rare in Oklahoma by Robison (1975) and has a spotty distribution in eastern Oklahoma (Miller and Robison 1973). The channel catfish and the flathead catfish both seem to do quite well in the study area, preferring the main body of the lake to the smaller tributary streams (Jenkins and Leonard 1952, McCoy 1953 and Houser 1960).

The Mississippi silverside is an abundant species both in the lake and in the river below Fort Gibson Dam. Fifteen years ago it was known only from the Red River drainage in Oklahoma, but is now known to be widespread in the large reservoirs of the Arkansas watershed (University of Tulsa 1977). Gomez and Lindsay (1972), previously reported on the history of the dispersion of this species. *Menidia* is second only to gizzard shad in its importance as a shoreline as well as pelagic forage fish. White bass, largemouth bass, and white crappie continue to show tremendous success in the main body of the lake. While the smallmouth bass may be found locally abundant in some eastern tributaries, its success is very limited in the reservoir area. It is probably absent from the western tributaries. Spotted bass are fairly common in tributaries and may occur rarely in the main body of the lake.

Sunfishes seem to thrive in the area. Orangespotted sunfish are common in the western tributaries but mostly absent from the eastern

ones. The red-eared sunfish is found only rarely. Bluegill are a successful and desirable species common in the lake and its tributaries (University of Tulsa 1977). The black crappie is present, but uncommon in the basin, occurring most often in the Neosho River below Fort Gibson Dam. It has more success in stream situations than in lakes. The walleye is seasonally abundant in the Neosho River below Fort Gibson Dam. Logperch and channel darters both occur along the shoreline of the lake. The bluntnose darter and the slough darter are present mostly in the western tributary streams of the area. Orangethroat darters are the most widespread and abundant of Oklahoma's darters and occurs in the tributary streams of both sides of the lake. Freshwater drum, a fish of large lakes and large streams, is known to be a common inhabitant of Fort Gibson Reservoir and in the river below Fort Gibson Dam (University of Tulsa 1977).

A commercial mussel fishery exists in Fort Gibson Reservoir; the reservoir is presently a major source of mussel shells that are of excellent quality for use in the cultured pearl industry. The shells are abundant and readily harvested. Since 1975 the shell harvest has provided an important source of income to many of the area residents (Donovan 1978).

According to Donovan (1978), two commercial species dominate the Fort Gibson Reservoir mussel community, *Quadrula quadrula* and *Amblema cotata*. Adults dominate these populations and recruitment appears to be very low. Two other species *Obliquaria reflexa* and *Quadrula pustulosa* appear to be expanding their populations. A list of mussels collected by Donovan from Fort Gibson Reservoir, in order of decreasing abundance, appears in Table 37.

Chouteau Creek would be traversed by the Proposed Action at MP 810.5 in Mayes County, Oklahoma. The fish fauna of this tributary to Fort Gibson Reservoir is composed primarily of gizzard shad, red shiners,

Table 37 UNIONID MUSSELS, IN ORDER OF DECREASING ABUNDANCE, COLLECTED BY DONOVAN (1978) FROM FORT GIBSON RESERVOIR

*Quadrula quadrula*

*Amblema costata*

*Obliquaria reflexa*

*Quadrula pustulosa*

*Lasmigona complanata*

*Anodonta grandis*

*Proptera purpurata*

*Leptodea fragilis*

*Leptodea laevissima*

*Anodonta imbecilis*

*Carunculina parva*

*Lampsilis ovata ventricosa*

*Truncilla donaciformis*

*Truncilla truncata*

mosquitofish, Mississippi silverside black crappie, bluegill, yellow bullheads, blackstripe topminnows, white crappie, white bass, longear sunfish and drum (University of Tulsa 1977).

Flat Rock Creek would be traversed by the Proposed Action at MP 819. Fishes common in this stream include gizzard shad, carp, mosquitofish, green sunfish, orangespotted sunfish, bluegill and white crappie.

Brush Creek, a tributary to Fort Gibson Reservoir, would be traversed by the Proposed Action in Mayes County at approximately MP 812. The University of Tulsa collected gizzard shad, blackstripe topminnows, mosquitofish, brook silversides, largemouth bass, warmouth, longear sunfish, orangespotted sunfish, bluegill, white crappie and slough darters from Brush Creek.

Striped bass are not native to Oklahoma and, in fact, are by nature an estuarine species. Although saltwater stripers live most of their lives in ocean bays and estuaries, they ascend freshwater streams to spawn.

A freshwater population of striped bass, developed in the reservoirs of the Santee-Cooper River in South Carolina, was the source of the fingerlings introduced into larger Oklahoma reservoirs. Breeding populations presently occur in Keystone and Texoma reservoirs and in the Arkansas River system.

In Oklahoma, striped bass spawning peaks around the end of April or the first of May when water temperatures are between 60 and 65°F (Mensinger 1971). Rivers between 5 and 20 feet deep with constantly moving water are necessary for successful reproduction. If the current is too slow the eggs or larvae will settle and suffocate (Stevens 1967, Bigelow and Schroeder 1953).

The eggs are typically deposited near the surface (Raney 1954) and are buoyant (Mansueti 1958) or semibuoyant (Raney 1958, Merriman 1937). The eggs are slightly heavier than freshwater (Raney 1952, Mansueti 1958), but are easily floated by agitation. After spawning the eggs drift with the currents (Erkkila et al. 1950) and Talbot (1966) believed that unsuspended eggs, generally resulting from a lack of current, have little chance for survival unless they settle in sandy or rocky areas with well oxygenated water (Stevens 1966).

According to Mansueti (1958) and Pearson (1938), hatching takes place about 48 hours after spawning, although hatching times at extreme water temperatures will vary considerably; hatching time at 23.9°C takes approximately 29 hours (Neal 1964) while 80 hours are needed for hatching at 12.2°C (Mansueti 1958, Doroshev 1970).

Reservoir populations of white bass in Oklahoma are, for the most part, tributary spawners although shoal areas in lakes which lack tributaries may also be used (Baglin and Hill 1977 and Bonn 1953). The tributary spawners usually broadcast their eggs over sand or gravel in depths between 2 and 8 feet. Spawning typically begins when the water temperatures reach 50°F and lasts for about 2 weeks in any one location (Riggs 1953).

Arkansas

The Proposed Action through Arkansas would traverse portions of the Arkansas, White and Ouachita River basins. The Arkansas Commission on Pollution Control and Ecology has established a classifications scheme for all surface waters in Arkansas based upon the principal water use and primary fish population. Class types are defined as follows:

Class AA: Extraordinary recreational and aesthetic value. Suitable for primary contact recreation, propagation of desirable species of fish, wildlife and other aquatic life, raw water source for public water supplies, and other compatible uses.

Streams and rivers which would be traversed by the Proposed Action through Arkansas are listed in Tables 38 and 39.

Arkansas River Basin. In Arkansas this basin extends southeasterly across the state from Oklahoma and Missouri state lines to the Mississippi River. The Proposed Action would enter the Arkansas portion of the basin at the Oklahoma-Arkansas state line and would leave the drainage at approximately MP 1090 in Jefferson County. The Independence Lateral would originate in the basin and leave the basin at approximately MP 55.

Lee Creek would be traversed by the Proposed Action at MP 904.5 in Crawford County, Arkansas. The Lee Creek watershed lies north of the Arkansas River in western Arkansas and eastern Oklahoma. The basin, about 32 miles long and averaging about 14 miles in width, comprises an area of approximately 450 square miles, with 267 square miles located in Washington and Crawford counties, Arkansas, and with 183 square miles located in Adair and Sequoyah counties, Oklahoma. It is bordered on the north by the White and Illinois River basins, on the east by the Frog Bayou basin, on the south by the Arkansas River, and on the west by the Sallisaw Creek basin.

Lee Creek is a tributary of the Arkansas River entering the river about 1 mile upstream from Van Buren, Arkansas, at navigation mile 302.2 The stream flows southwesterly from the headwaters in Washington County, Arkansas, into Oklahoma, then southeasterly to its confluence with the Arkansas River. It drains 450 square miles of generally rugged terrain, of which about one-fourth is in the Ozark National Forest. The valley of the creek is generally narrow and has steep slopes except in the lower reaches where it widens and merges into the floodplain of the Arkansas River (U.S. Army Corps of Engineers 1979b). The stream is characterized by moderately swift shoals and deep pools. Within the headwaters, the stream is intermittent during the dry season most years.

Table 38 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION AND MARKET ALTERNATIVE THROUGH ARKANSAS (MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Lee Creek | 904.5 | P | Crawford |
| UT Lee Creek | 907 | P | Crawford |
| UT Lee Creek | 908.5 | P | Crawford |
| Frog Bayou | 915 | P | Crawford |
| Little Frog Bayou | 919.5 | P | Crawford |
| UT Arkansas River | 926 | P | Crawford |
| UT Arkansas River | 926.5 | P | Crawford |
| Little Mulberry River | 927.5 | P | Crawford |
| Mulberry River[1] | 929 | P | Crawford |
| UT Mulberry River | 930 | P | Franklin |
| UT Arkansas River | 934 | I | Franklin |
| UT White Oak Creek | 936 | I | Franklin |
| UT White Oak Creek | 938 | I | Franklin |
| N. Fork White Oak Creek | 939 | I | Franklin |
| UT S. Fork White Oak Creek | 940 | I | Franklin |
| S. Fork White Oak Creek | 942 | I | Franklin |
| UT S. Fork White Oak Creek | 943 | I | Franklin |
| E. Fork Gar Creek | 944 | I | Franklin |
| UT McKinney Creek | 947 | I | Franklin |
| UT McKinney Creek | 948 | I | Franklin |
| UT McKinney Creek | 949 | I | Johnson |
| UT McKinney Creek | 950.5 | I | Johnson |
| UT McKinney Creek | 951 | I | Johnson |
| Horsehead Creek | 953 | P | Johnson |
| UT E. Fork Horsehead Creek | 954 | I | Johnson |
| E. Fork Horsehead Creek | 955 | P | Johnson |
| UT Spadra Creek | 958 | I | Johnson |
| UT Spadra Creek | 962 | I | Johnson |
| UT Spadra Creek | 963 | I | Johnson |
| Spadra Creek | 964 | P | Johnson |
| UT Spadra Creek | 966 | I | Johnson |
| UT Little Piney Creek | 969 | I | Johnson |
| Little Piney Creek | 972 | P | Johnson |
| Big Piney Creek | 974 | P | Johnson |
| Illinois Bayou | 982 | P | Pope |
| UT Gum Log Creek | 989.5 | I | Pope |
| UT Gum Log Creek | 994 | I | Pope |
| Gum Log Creek | 1000 | P | Pope |
| Kuhn Bayou | 1005 | P | Conway |
| Arkansas River[1] | 1013 | P | Conway |
| UT Cypress Creek | 1014 | I | Conway |
| UT Cypress Creek | 1015 | I | Conway |
| UT Cypress Creek | 1015.5 | I | Perry |

Table 38 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Cypress Creek | 1018 | P | Perry |
| Fourche La Fave River | 1022 | P | Perry |
| Maumelle River | 1033 | P | Pulaski |
| UT Lake Maumelle | 1035 | I | Pulaski |
| Nolan Creek | 1036 | I | Pulaski |
| Neal Creek | 1038 | I | Pulaski |
| Little Maumelle River | 1043 | I | Pulaski |
| UT Little Maumelle River | 1043.5 | I | Pulaski |
| Fourche Creek | 1056 | P | Saline |
| UT Fourche Creek | 1056.5 | P | Saline |
| UT Lorance Creek | 1060.5 | I | Saline |
| UT Lorance Creek | 1061 | I | Saline |
| UT Lorance Creek | 1061.5 | I | Pulaski |
| Lorance Creek | 1063 | P | Saline |
| Maple Creek | 1065 | I | Saline |
| UT Maple Creek | 1066 | I | Saline |
| Clear Creek | 1068 | P | Saline |
| UT Clear Creek | 1069 | I | Pulaski |
| UT Pennington Bayou | 1071 | I | Pulaski |
| UT Turkey Creek | 1073 | I | Grant |
| Turkey Creek | 1073.5 | I | Jefferson |
| Tar Camp Creek | 1075 | I | Jefferson |
| Love Creek | 1079 | I | Jefferson |
| UT Eastwood Bayou | 1081 | I | Jefferson |
| Eastwood Bayou | 1082 | I | Jefferson |
| Caney Bayou | 1083 | I | Jefferson |
| Bayou Bartholomew | 1089 | I | Jefferson |
| Big Creek | 1099 | I | Jefferson |
| Big Creek | 1103 | P | Cleveland |
| Big Creek | 1110 | P | Cleveland |
| Saline River[1] | 1120 | P | Cleveland |
| UT Saline River | 1123 | P | Cleveland |
| UT Saline River | 1123.5 | P | Cleveland |
| UT Saline River | 1127 | I | Cleveland |
| UT Saline River | 1129 | I | Bradley |
| UT Saline River | 1132 | I | Bradley |
| Franklin Creek | 1134 | I | Bradley |
| Brushy L'Aigle Creek | 1139 | P | Bradley |
| Grassy Pond Creek | 1145 | I | Bradley |
| UT Grassy Pond Creek | 1148 | I | Bradley |
| Snake Creek | 1158 | P | Bradley |
| Saline River[1] | 1161 | P | Bradley |
| Brushy Creek | 1167 | P | Ashley |
| Coffee Creek | 1173 | P | Ashley |
| Coffee Creek | 1173.5 | P | Ashley |
| Coffee Creek | 1174 | P | Ashley |

Table 39 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE INDEPENDENCE LATERAL THROUGH ARKANSAS
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| W. Fork Point Remove Creek | 3 | I | Pope |
| UT W. Fork Point Remove Creek | 8 | I | Conway |
| UT W. Fork Point Remove Creek | 9 | I | Conway |
| UT E. Fork Point Remove Creek | 13 | I | Conway |
| E. Fork Point Remove Creek | 15 | P | Conway |
| UT E. Fork Point Remove Creek | 16 | I | Conway |
| UT E. Fork Point Remove Creek | 19 | I | Conway |
| UT E. Fork Point Remove Creek | 20 | I | Conway |
| UT Hogan's Creek | 22 | I | Conway |
| UT Hogan's Creek | 24 | I | Conway |
| UT Pine Mountain Creek | 28 | I | Van Buren |
| UT Pine Mountain Creek | 31 | I | Van Buren |
| UT Pine Mountain Creek | 31.5 | I | Van Buren |
| N. Fork Cadron Creek | 35 | P | Van Buren |
| UT N. Fork Cadron Creek | 37 | I | Van Buren |
| UT N. Fork Cadron Creek | 38 | I | Van Buren |
| UT Cadron Creek | 43 | I | Cleburne |
| Cove Creek | 47 | I | Cleburne |
| UT Little Red River | 53 | I | Cleburne |
| UT Little Red River | 55.5 | I | Cleburne |
| Little Red River | 60.5 | P | Cleburne |
| Wilburn Creek | 63 | I | Cleburne |
| Big Creek | 68 | P | Independence |
| Elbow Creek | 71 | I | Independence |
| UT Tenmile Creek | 74 | I | Independence |
| UT Tenmile Creek | 75 | I | Independence |
| UT Departee Creek | 81 | I | Independence |
| UT Departee Creek | 83 | I | Independence |
| UT Departee Creek | 85 | I | Independence |
| UT Departee Creek | 88 | I | Independence |
| Unnamed stream | 91.5 | P | Independence |
| White River[1] | 93 | P | Independence |

The vegetation of the entire Lee Creek basin is typically Ozarkian in character. The woody vegetation, in particular, is the prevailing forest type throughout most of the northern part of Arkansas. Various mixtures of oak and hickory provide the dominant species on most sites over the area (U.S. Army Corps of Engineers 1979b). Semi-aquatic vegetation in Lee Creek consists of watercress, water starwort, buttonbush, and various sedges and rushes. Small tributaries having less volume and velocity often have thickets of common alder.

Spotted bass appear to be the most numerous game fish in the downstream portions of Lee Creek and is primarily found in large pools. Smallmouth bass are probably the next most abundant game species and are found mostly in or near riffles. They are very likely the most sought-after game fish in the Lee Creek basin (U.S. Army Corps of Engineers 1979b). Other sportfishes include bluegill, green sunfish, warmouth, and rock bass, along with three species of suckers. Over a dozen species of minnows are present and they, with mussels, crayfish, insects, and tadpoles, are probably the major food items in the diet of adult game fish in Lee Creek. Principal migrating species include white bass, largemouth bass, sauger, crappie, channel and flathead catfish, northern hogsucker, golden redhorses, smallmouth buffalo, freshwater drum and gizzard shad (U.S. Army Corps of Engineers 1979b).

The Little Mulberry and Mulberry rivers would be crossed by the Proposed Action at MP 927.5 and 929.5, respectively, near their confluence with the Arkansas River in Crawford County, Arkansas. The Mulberry River originates in the Boston Mountains in Newton County, Arkansas and flows southwesterly 62 miles before discharging into the Arkansas River at approximately navigation mile 263.5. The Mulberry River drains slightly over 810 sq miles of generally rugged terrain. The river averages about 115 feet in width and 3 feet in depth (Olmsted et al. 1972). The bottom is generally rocky or gravelly until the last 6 miles before its confluence with the Arkansas River

where it becomes muddy and silty. The gradient is high with approximately 25 percent of the river forming riffle habitat (U.S. Army Corps of Engineers 1971).

In recent years the lower stretch of the Mulberry River has been drastically altered by completion of the McClellan-Kerr Navigation Project on the Arkansas River. The construction of Ozark Lake on the Arkansas River has created backwater areas in the lower five miles of the Mulberry River, transforming it into a turbid, big river habitat. In the future, backwater will extend slightly further up the channel as a result of sedimentation in Ozark Lake. The Proposed Action route would traverse the Mulberry River in this backwater area.

The upper and middle portions of the Mulberry River are still relatively unspoiled. Because of the river's natural scenic beauty, it has been included in the proposed Arkansas Scenic Rivers System.

As expected in moderately sized midwestern rivers (Starrett 1950), the fish species diversity in the Mulberry River increases from its origin to the confluence with the Arkansas River.

Spotted and longnose gar are probably common in the lower portions of the Mulberry River, especially in areas with deeper holes. Near the confluence of the Walnut and Arkansas rivers gizzard shad are the most abundant fish (Olmsted et al. 1972) showing a preference for slow water of the main channel and wooded coves. Threadfin shad also occur commonly in the mouth of the Mulberry River and are second in abundance only to the gizzard shad near the confluence.

Stonerollers are common throughout the Mulberry River particularly in riffle habitat. Carp, although present throughout the Mulberry River, are only abundant in the lower portions near the Arkansas River. The turbid, slack-water areas in the lower section of the Mulberry River provide optimum habitat for this species.

Emerald shiners are common in the lower portion of the Mulberry River (Olmsted et al. 1972). Wedgespot shiners are common or abundant in the middle section of the river but uncommon in the headwaters and the lower section. The preferred habitat of wedgespot shiners is riffles and pools with gravel bottoms and emergent vegetation.

The quiet water and sandy bottoms of the lower section of the Mulberry River represents good habitat for the red shiners. The red shiners are apparently restricted to the lower segment. Steelcolor shiners are abundant throughout most of the drainage (Olmsted et al. 1972).

Although bluntnose minnows are abundant in the headwaters and middle portion of the Mulberry River, they are replaced by bullhead minnows in the more turbid lower section.

Deep-bodied suckers are most common near the river's confluence with the Arkansas River. Representative species include river carpsucker, smallmouth buffalo and bigmouth buffalo. Redhorses, although found mostly in the lower sections, are occasionally found in the middle section and rarely in the headwaters.

Channel catfish are common in the Mulberry River and are most often taken from the deeper pools of the lower segment. Flathead catfish distribution and habitat preference is similar to those of the channel catfish. The only other ictalurid collected by Olmsted and others from the Mulberry River were slender madtoms.

Blackspotted topminnows, mosquitofish, brook silversides and Mississippi silversides are common or abundant in backwater areas of the river.

White bass probably utilize portions of the Mulberry River during spring spawning. Normally, white bass tends to be a limnetic species preferring deeper channels near the mouth.

Green sunfish are common throughout the Mulberry basin (Olmsted et al. 1972), while most large bluegill appear restricted to the lower section. Large longear and redear sunfish occur most commonly in the lower Mulberry River. Largemouth bass occur in the deeper holes of the lower section of the Mulberry River, while the less tolerant spotted and smallmouth bass appear restricted to the upper and middle portions of the river. Crappie may also occur in deeper pools in the river.

Freshwater drum are common in the lower portion of the Mulberry River. Drum generally prefer deep turbid waters of the main channel of rivers.

The Proposed Action would cross the Arkansas River at MP 1012 in Conway County. From the Oklahoma-Arkansas state line to Lock and Dam No. 12, south of approximately MP 943, the Arkansas River is classified as a Class B river. This section of the Arkansas has been sampled annually since 1973 (Rider and Limbird 1979). Most of the fish population in the Arkansas River consists of forage fish including buffalo, carpsucker, carp, spotted suckers, redhorses, drum, shad, minnows and shiners.

Downstream from Lock and Dam No. 12, including the stretch which would be traversed by the Proposed Action (MP 1013), the Arkansas River is classified as Class A waters.

The construction of the McClellan-Kerr Navigation System and the impoundment between Lock and Dam No. 5 and the David D. Terry Lock and Dam has changed the fishery of the Arkansas River from a riverine to a more lacustrine type. Consequently, there has been a noted increase in

the fishing success for crappie and largemouth bass in recent years. Important game species found in the Arkansas River, associated oxbows, and larger tributaries would classify the surface waters of the study area as crappie and catfish habitat. The dominant species comprising the sport fishery of the region include black and white crappie, channel catfish, blue catfish, largemouth bass, and striped bass (Rider and Limbird 1979).

Prime fishery areas in the Arkansas River are mostly located in backwater sloughs, oxbows and tributary embayments. These areas are essential as spawning and nursery areas.

Benthic organisms in the Arkansas River would generally consist of insect larvae, clams, snails, and other invertebrate animals which inhabit the bottoms of bayous, lakes, and streams. In a study sponsored by the Little Rock District, U.S. Army Corps of Engineers (Arkansas Power and Light Co. 1978), the dominant benthic organisms were found to be the bivalve Corbicula and dipteran larvae of the family Chironomidae.

Cypress Creek would be crossed by the Proposed Action at MP 1018 in Conway County, Arkansas just south of the Arkansas River. The Cypress Creek basin lies within the Arkansas River valley subdivision of the Ouachita Mountain Province (Arkansas Dept. of Planning 1974). The drainage pattern in the basin is dendritic (U.S. Army Corps of Engineers 1979a). In the upstream portions of the basin, Cypress Creek flows over bedrock. The Proposed Action would cross Cypress Creek in the downstream segment which flows over alluvium and follows a meandering course between relatively narrow floodplains.

Aquatic vegetation is not abundant in the Cypress Creek watershed. Small growths of water willow (Justicia spp.) and water lily (Nymphaea spp.) may be found bordering quiet pools, especially in the lower end of the pools (U. S. Army Corps of Engineers 1979a). Three different plant communities can be identified in the Cypress Creek basin. In or

on the bank of the creek is a community dominated by bald cypress and water elm. Along the creek itself there is a community composed of water oak, willow oak, sweetgum, river birch, ash and elm. The third community, found in areas away from the creek, is dominated by red oak, white oak and black oak. Although most of the watershed was at one time forest, large areas were cleared for cropland and pasture. Improved pasture species include fescue, Bermuda grass, Bahia grass, hop clover and annual lespedeza. Unimproved pastures contain little bluestem, broom sedge, Dallasgrass, split beard, low panicum, ragweed and sneezeweed.

Cypress Creek supports a diverse aquatic invertebrate fauna indicative of the streams good water quality. About 70 species of fish probably occur in the Cypress Creek basin (U. S. Army Corps of Engineers 1979a). Larger pools in the stream probably contain populations of spotted and largemouth bass, channel catfish, green sunfish and bluegill. Carp, drum and an occasional gar may also occur.

Fourche Creek would be traversed by the Proposed Action at MP 1056 in Saline County. Fourche Creek's ichthyofauna consists of smallmouth bass, crappie, sunfish, catfish and shiners. Although the headwaters of Fourche Creek support a diverse invertebrate fauna consisting of stoneflies, caddisflies and mayflies, the downstream portion near Little Rock has been severely affected by industrial pollution (Arkansas Power and Light Co. 1978).

White River Basin. From approximately MP 55 to the Independence Site the Independence Lateral would traverse the White River basin. Streams and Rivers which would be traversed by the Independence Lateral are listed in Table 39.

The White River in central Arkansas is a large sluggish river which supports barge traffic and commercial sand and gravel dredging. These operations have had significant effects on the aquatic biota and available habitat in the White River. Barge traffic and fluctuating water levels have created steep banks along much of the shoreline. Commercial dredging for sand and gravel has undoubtedly affected the ecological characteristics of the bottom habitat and related benthic populations.

The White River would be traversed by the Independence Lateral at MP 93 in Independence County, Arkansas. Dominant forest species include several species of oak and hickory, ash, elm and blackgum. Osage orange is also present especially along fence rows. Significant populations of aquatic hydrophytes are generally absent from the White River. A few stands of arrowhead (Sagittaria sp.) and duckweed (Lemna sp.) may occur. In addition, portions of the floodplain are characterized by the presence of terrestrial species that are submerged during periods of high water but dry when the water level is low.

A list of fishes collected from the White River at the proposed Independence Lateral crossing appears in Table 40. The list was compiled from data presented by the U.S. Environmental Protection Agency (1978). The benthic fauna of the White River is presented in Table 41 and mussels appear in Table 42.

Table 40 FISHES KNOWN TO OCCUR IN THE WHITE RIVER, ARKANSAS NEAR THE PROPOSED INDEPENDENCE LATERAL CROSSING (U.S. ENVIRONMENTAL PROTECTION AGENCY 1978)

| Scientific Name | Common Name |
|---|---|
| Petromyzontidae | |
| *Ichthyomyzon castaneus* | Chestnut lamprey |
| *I. gagei* | Southern brook lamprey |
| Polyodontidae | |
| *Polyodon spathula* | Paddlefish |
| Lepisostidae | |
| *Lepisosteus osseus* | Longnose gar |
| *L. platostomus* | Shortnose gar |
| *L. spatula* | Alligator gar |
| Amiidae | |
| *Amia calva* | Bowfin |
| Clupeidae | |
| *Alosa chrysochloris* | Skipjack herring |
| *Dorosoma cepedianum* | Gizzard shad |
| *D. petenense* | Threadfin shad |
| Hiodontidae | |
| *Hiodon alosoides* | Goldeye |
| *H. tergisus* | Mooneye |
| Esocidae | |
| *Esox lucius* | Northern pike |
| *E. niger* | Chain pickerel |
| Cyprinidae | |
| *Campostoma anomalum* | Stoneroller |
| *C. oligolepis* | Largescale stoneroller |
| *Carassius auratus* | Goldfish |

Table 40 (continued)

| | |
|---|---|
| Cyprinidae (cont'd) | |
| Cyprinus carpio | Carp |
| Dionda nubila | Ozark minnow |
| Hybognathus hayi | Cypress minnow |
| H. nuchalis | Silvery minnow |
| Hybopsis aestivalis | Speckled chub |
| H. amblops | Bigeye chub |
| H. dissimilis | Streamline chub |
| H. storeriana | Silver chub |
| H. x-punctata | Gravel chub |
| Nocomis biggutatus | Hornyhead chub |
| Notemigonus chrysoleucas | Golden shiner |
| Notropis atherinoides | Emerald shiner |
| N. boops | Bigeye shiner |
| N. chrysocephalus | Striped shiner |
| N. emiliae | Pugnose minnow |
| N. galacturus | Whitetail shiner |
| N. greenei | Wedgespot shiner |
| N. ozarcanus | Ozark shiner |
| N. pilsbryi | Duskystripe shiner |
| N. rubellus | Rosyface shiner |
| N. sabinae | Sabine shiner |
| N. telescopus | Telescope shiner |
| N. texanus | Weed shiner |
| N. umbratilis | Redfin shiner |
| N. venustus | Blacktail shiner |
| N. volucellus | Mimic shiner |
| N. whipplei | Steelcolor shiner |
| Phoxinus erythrogaster | Southern redbelly dace |
| Pimephales notatus | Bluntnose minnow |
| P. promelas | Fathead minnow |
| P. tenellus | Slim minnow |
| P. vigilax | Bullhead minnow |
| Semotilus atromaculatus | Creek chub |

| | |
|---|---|
| Catostomidae | |
| *Carpiodes carpio* | River carpsucker |
| *C. cyprinus* | Quillback |
| *C. velifer* | Highfin carpsucker |
| *Erimyzon oblongus* | Creek chubsucker |
| *Hypentelium nigricans* | Northern hog sucker |
| *Ictiobus bubalus* | Smallmouth buffalo |
| *I. cyprinellus* | Bigmouth buffalo |
| *I. niger* | Black buffalo |
| *Minytrema melanops* | Spotted sucker |
| *Moxostoma carinatum* | River redhorse |
| *M. duquesnei* | Black redhorse |
| *M. erythrurum* | Golden redhorse |
| *M. macrolepidotum* | Shorthead redhorse |
| Ictaluridae | |
| *Ictalurus furcatus* | Blue catfish |
| *I. melas* | Black bullhead |
| *I. natalis* | Yellow bullhead |
| *I. punctatus* | Channel catfish |
| *Noturus exilis* | Slender madtom |
| *N. flavater* | Checkered madtom |
| *N. gyrinus* | Tadpole madtom |
| *N. miurus* | Brindled madtom |
| *Pylodictis olivaris* | Flathead catfish |
| Aphredoderidae | |
| *Aphredoderus sayanus* | Pirate perch |
| Cyprinodontidae | |
| *Fundulus catenatus* | Northern studfish |
| *F. olivaceus* | Blackspotted topminnow |
| Poeciliidae | |
| *Gambusia affinis* | Mosquitofish |

| | |
|---|---|
| Atherinidae | |
| Labidesthes sicculus | Brook silverside |
| Percicthyidae | |
| Morone chrysops | White bass |
| Centrarchidae | |
| Ambloplites rupestris | Rock bass |
| Elassoma zonatum | Banded pygmy sunfish |
| Lepomis cyanellus | Green sunfish |
| L. gulosus | Warmouth |
| L. humilis | Orangespotted sunfish |
| L. macrochirus | Bluegill |
| L. marginatus | Dollar sunfish |
| L. megalotis | Longear sunfish |
| L. microlophus | Redear sunfish |
| L. punctatus | Spotted sunfish |
| Micropterus dolomieui | Smallmouth bass |
| M. punctulatus | Spotted bass |
| M. salmoides | Largemouth bass |
| Pomoxis annularis | White crappie |
| P. nigromaculatus | Black crappie |
| Percidae | |
| Ammocrypta asprella | Crystal darter |
| A. clara | Western sand darter |
| A. vivax | Scaly sand darter |
| Etheostoma blennioides | Greenside darter |
| E. caeruleum | Rainbow darter |
| E. chlorosomum | Bluntnose darter |
| E. euzonum | Arkansas saddled darter |
| E. histrio | Harlequin darter |
| E. punctulatum | Stippled darter |
| E. spectabile | Orangethroat darter |

Table 40 (concluded)

| | |
|---|---|
| Percidae (cont'd) | |
| *E. stigmaeum* | Speckled darter |
| *E. whipplei* | Redfin darter |
| *E. zonale* | Banded darter |
| *Percina caprodes* | Logperch |
| *P. evides* | Gilt darter |
| *P. maculata* | Blackside darter |
| *P. nasuta* | Longnose darter |
| *P. phoxocephala* | Slenderhead darter |
| *P. sciera* | Dusky darter |
| *P. shumardi* | River darter |
| *P. uranidea* | Stargazing darter |
| *Stizostedion canadense* | Sauger |
| *S. vitreum* | Walleye |
| Sciaenidae | |
| *Aplodinotus grunniens* | Freshwater drum |
| Cottidae | |
| *Cottus bairdi* | Mottled sculpin |
| *C. carolinae* | Banded sculpin |

Table 41 BENTHIC MACROINVERTEBRATES COLLECTED FROM THE WHITE RIVER, ARKANSAS NEAR THE PROPOSED INDEPENDENCE LATERAL CROSSING (U.S. ENVIRONMENTAL PROTECTION AGENCY 1978)

---

Diptera

Chironomidae
- Chironomus spp.
- Coelotanypus sp.
- Cricotopus spp.
- Cryptochironomus demeiji
- Cryptochironomus sp.
- Demicryptochironomus sp.
- Dicrotendipes sp.
- Harnischia spp.
- Micropsectra sp.
- Microtendipes aberrans
- Orthocladius sp.
- Paracladopelma sp.
- Paralauterborniella spp.
- Paratanytarsus sp.
- Paratendipes spp.
- Pentaneura sp.
- Phaenopsectra sp.
- Polypedilum spp.
- Procladius spp.
- Pseudochironomus spp.
- Rheotanytarsus spp.
- Tanypus sp.
- Tanytarsus coracina
- Tanytarsus spp.
- Tribelos sp.
- Trichocladius sp.
- Unidentified chironomid spp.
- Unidentified chironomid pupa
- Chironominae (unid. sp.)
- Tanypodinae (unid. sp.)

Culicidae
- Chaoborus sp.

Ceratopogonidae
- Probezzia sp.

Tabanidae
- Tabanus sp.

Ephemeroptera

Baetidae
- Baetis spp.

Caenidae
- Caenis Sp.

Ephemeridae
- Hexagenia sp.

Hemiptera

- Corixidae
  - Trichocorixa sp.
  - Unidentified sp.
- Gerridae
  - Trepobates sp.
  - Gerris sp.
- Notonectidae (unid. sp.)

Odonata

- Unidentified sp.

Trichoptera

- Hydroptilidae (unid. sp.)
- Molannidae
  - Molanna sp.

Coleoptera

- Elateridae (unid. sp.)
- Gyrinidae
  - Gyrinus sp.

Decapoda

- Astacidae
  - Palaemonetes sp.

Oligochaeta

- Lumbriculidae (unid. sp.)
- Naididae
  - Nais sp.
  - Paranais frici
- Tubificidae
  - Aulodrilus piqueti
  - Branchiura sowerbyi
  - Limnodrilus cervix
  - L. clapardeanus
  - L. hoffmeisteri
  - L. udekemianus
  - Immature tubificids
  - Unidentified sp.

Nematoda

- Unidentified sp.

Pelecypoda

- Corbiculidae
  - Corbicula sp.
- Unionidae
  - Amblema perplicata
  - Fusconaia ebena
  - Proptera laevissima

Table 42 UNIONID MUSSELS COLLECTED FROM THE WHITE RIVER, ARKANSAS NEAR THE PROPOSED INDEPENDENCE LATERAL CROSSING (U.S. ENVIRONMENTAL PROTECTION AGENCY 1978)

| |
|---|
| *Quadrula metanevra* |
| *Proptera alata* |
| *Plagiola lineolata* |
| *Ligumea recta* |
| *Lampsilis ovata* |
| *Fusconaia ebenus* |
| *Amblema constata* |
| *Fusconaia undata* |
| *Quadrula quadrula* |
| *Tritogonia verrucosa* |
| *Actinonais carinata* |
| *Leptodea fragilis* |
| *Obovaria olivaria* |

Quachita River Basin. The Proposed Action would enter the Quachita River basin at approximately MP 1090 in Jefferson County, and the remainder of the Proposed Action (MP 1090-1179.4) through Arkansas would lie in the Quachita basin. This basin drains an area of approximately 25,900 square miles in Arkansas and Louisiana.

The Saline River would be crossed by the Proposed Action in Cleveland and Bradley counties at MP 1118 and 1158, respectively. At the proposed river crossing locations the river has been classified Class A and B; considered highly valued fishery habitats (U.S. Department of Agriculture 1979a). In addition, the state of Arkansas has given the Saline River a use classification of A, which allows for primary contact recreation and other compatible uses.

The fish fauna of the Saline River includes many of the species listed in Table 43 which identifies fishes of the Ouachita basin. Sport fishes of major importance include smallmouth bass, crappie, bluegill and various sunfishes. Commercial species include buffalo, catfishes, and carp. Rough and forage fish include at least 15 darter species and 22 species of chubs, minnows, shiners, and drum.

The Saline River maintains the highest priority fish populations of any river which would be crossed by the Proposed Action in Arkasnas.

The invertebrate fauna of the Ouachita basin has not been extensively studied (Moore 1966; Gordon, etal. 1979). Gordon, etal. (1979) have recently completed a regional checklist of freshwater mussels. Several species of *Fusconaia*, *Quadrula*, *Lasmigora*, *Onodonta*, *Lampsilis*, and others have been collected from the basin.

Crayfishes are abundant and commercially harvestable (U.S. Department of Agriculture 1979b). Other invertebrates which would be expected

Table 43 FISHES INHABITING THE OUACHITA RIVER BASIN (A MINIMUM LIST, REORGANIZED) (U.S. DEPARTMENT OF AGRICULTURE 1979a)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY PETROMYZONTIDAE | LAMPREYS |
| *Ichthyomyzon gagei* | Southern brook lamprey |
| FAMILY ACIPENSERIDAE | STURGEONS |
| *Scaphirhynchus platorynchus* | Shovelnose sturgeon |
| FAMILY POLYODONTIDAE | PADDLEFISHES |
| *Polyodon spathula* | Paddlefish |
| FAMILY LEPISOSTEIDAE | GARS |
| *Lepisosteus oculatus* | Spotted gar |
| *Lepisosteus osseus* | Longnose gar |
| *Lepisosteus platostomus* | Shortnose gar |
| *Lepisosteus spatula* | Alligator gar |
| FAMILY AMIIDAE | BOWFIN |
| *Amia calva* | Bowfin |
| FAMILY ANGUILLIDAE | EELS |
| *Anguilla rostrata* | American eel |
| FAMILY CLUPEIDAE | SHADS |
| *Alosa chrysochloris* | Skipjack herring |
| *Dorosoma cepedianum* | Gizzard shad |
| *Dorosoma petenense* | Threadfin shad |
| FAMILY HIODONTIDAE | MOONEYES |
| *Hiodon alosoides* | Goldeye |
| *Hiodon tergisus* | Mooneye |
| FAMILY ESOCIDAE | PIKES |
| *Esox americanus* | Redfin pickerel |
| *Esox niger* | Chain pickerel |
| FAMILY CYPRINIDAE | MINNOWS |
| *Campostoma anomalum* | Stoneroller |
| *Cyprinus carpio* | Carp |
| *Hybognathus hayi* | Cypress minnow |
| *Hybognathus nuchalis* | Silvery minnow |
| *Hybopsis aestivalis* | Speckled chub |
| *Hybopsis gracilis* | Flathead chub |
| *Hybopsis storeriana* | Silver chub |
| *Hybopsis winchelli* | Clear chub |
| *Hybopsis x-punctatus* | Gravel chub |

Table 43 (continued)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY CYPRINIDAE (continued) | MINNOWS |
| *Nocomis asper* | Redspot chub |
| *Notemigonus crysoleucas* | Golden shiner |
| *Notropis amnis* | Pallid shiner |
| *Notropis atherinoides* | Emerald shiner |
| *Notropis blennius* | River shiner |
| *Notropis boops* | Bigeye shiner |
| *Notropis buchanani* | Ghost shiner |
| *Notropis chalybaeus* | Ironcolor shiner |
| *Notropis chrysocephalus* | Striped shiner |
| *Notropis emiliae* | Pugnose minnow |
| *Notropis fumeus* | Ribbon shiner |
| *Notropis longirostris* | Longnose shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis maculatus* | Taillight shiner |
| *Notropis perpallidus* | Colorless shiner |
| *Notropis potteri* | Chub shiner |
| *Notropis roseipinnis* | Cherryfin shiner |
| *Notropis rubella* | Rosyface shiner |
| *Notropis sabinae* | Sabine shiner |
| *Notropis shumardi* | Silverband shiner |
| *Notropis texanus* | Weed shiner |
| *Notropis umbratilis* | Redfin shiner |
| *Notropis venustus* | Blacktail shiner |
| *Notropis volucellus* | Mimic shiner |
| *Notropis whipplei* | Steelcolor shiner |
| *Pimephales notatus* | Bluntnose minnow |
| *Pimephales promelas* | Fathead minnow |
| *Semotilus atromaculatus* | Creek chub |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Hypentelium nigricans* | Northern hogsucker |
| *Ictiobus bubalus* | Smallmouth buffalo |
| *Ictiobus cyprinellus* | Bigmouth buffalo |
| *Ictiobus niger* | Black buffalo |
| *Minytrema melanops* | Spotted sucker |
| *Moxostoma poecilurum* | Blacktail redhorse |

Table 43 (continued)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus furcatus* | Blue catfish |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus natalis* | Yellow bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus eleutherus* | Mountain madtom |
| *Noturus gyrinus* | Tadpole madtom |
| *Noturus lachneri* | Ouachita madtom |
| *Noturus miurus* | Brindled madtom |
| *Noturus nocturnus* | Freckled madtom |
| *Noturus phaeus* | Brown madtom |
| *Noturus taylori* | Caddo madtom |
| *Pylodictis olivaris* | Flathead catfish |
| FAMILY APHREDODERIDAE | PIRATE PERCH |
| *Aphredoderus sayanus* | Pirate perch |
| FAMILY CYPRINODONTIDAE | TOPMINNOWS |
| *Fundulus catenatus* | Northern studfish |
| *Fundulus chrysotus* | Golden topminnow |
| *Fundulus notatus* | Blackstripe topminnow |
| *Fundulus notti* | Starhead topminnow |
| *Fundulus olivaceus* | Blackspotted topminnow |
| FAMILY POECILIIDAE | LIVEBEARERS |
| *Gambusia affinis* | Mosquitofish |
| FAMILY ATHERINIDAE | SILVERSIDES |
| *Labidesthes sicculus* | Brook silverside |
| *Menidia audens* | Mississippi silverside |
| FAMILY SYNGNATHIDAE | PIPEFISHES |
| *Syngnathus scovelli* | Gulf pipefish |
| FAMILY PERCICHTHYIDAE | TEMPERATE BASSES |
| *Morone chrysops* | White bass |
| *Morone mississippiensis* | Yellow bass |
| *Morone saxatilis* | Striped bass |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Centrarchus macropterus* | Flier |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis gulosus* | Warmouth |
| *Lepomis humilis* | Orangespotted sunfish |
| *Lepomis macrochirus* | Bluegill |

Table 43 (concluded)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY CENTRARCHIDAE (continued) | |
| *Lepomis marginatus* | Dollar sunfish |
| *Lepomis megalotis* | Longear sunfish |
| *Lepomis microlophus* | Redear sunfish |
| *Lepomis symmetricus* | Bantam sunfish |
| *Micropterus punctulatus* | Spotted bass |
| *Micropterus salmoides* | Largemouth bass |
| *Pomoxis annularis* | White crappie |
| *Pomoxis nigromaculatus* | Black crappie |
| FAMILY ELASSOMATIDAE | PYGMY SUNFISHES |
| *Elassoma zonatum* | Banded pygmy sunfish |
| FAMILY PERCIDAE | PERCHES |
| *Ammocrypta asprella* | Crystal darter |
| *Ammocrypta vivax* | Scaly sand darter |
| *Etheostoma asprigene* | Mud darter |
| *Etheostoma blennioides* | Greenside darter |
| *Etheostoma chlorosomum* | Bluntnose darter |
| *Etheostoma collettei* | Creole darter |
| *Etheostoma fusiforme* | Swamp darter |
| *Etheostoma gracile* | Slough darter |
| *Etheostoma histrio* | Harlequin darter |
| *Etheostoma pallididorsum* | Paleback darter |
| *Etheostoma parvipinne* | Goldstripe darter |
| *Etheostoma proeliare* | Cypress darter |
| *Etheostoma radiosum* | Orangebelly darter |
| *Etheostoma stigmaeum* | Speckled darter |
| *Etheostoma whipplei* | Redfin darter |
| *Etheostoma zonale* | Banded darter |
| *Percina caprodes* | Logperch |
| *Percina copelandi* | Channel darter |
| *Percina maculata* | Blackside darter |
| *Percina sciera* | Dusky darter |
| *Percina shumardi* | River darter |
| *Percina uranidea* | Stargazing darter |
| *Stizostedion canadense* | Sauger |
| *Stizostedion vitreum vitreum* | Walleye |
| FAMILY SCIAENIDAE | DRUMS |
| *Aplodinotus grunniens* | Freshwater drum |

include flies (Diptera), caddisflies (Trichoptera), oligochaetes, dragonflies and damselflies (Odonata), mayflies (Ephemeroptera), and larval and adult beetles (Coleoptera).

The Ouachita basin is heavily wooded and even where agricultural fields have been plowed near stream and river beds there is generally a dense strip of riparian vegetation separating the stream from the field.

Louisiana

Streams and rivers which would be crossed by the Proposed Action through Louisiana are listed in Table 44. The Proposed Action and its laterals and extensions would cross portions of the following drainage basins in Louisiana (Douglas 1974);

Ouachita River Basin
Red River Basin
Calcasieu River Basin
Mermentau River Basin
Atchafalaya River Basin
Bayou Lafourche Basin
Lower Mississippi River Basin

Some characteristics of the Ouachita basin were described in Section 2.1.3.5, above. The first river which would be crossed by the Proposed Action in Louisiana would be Shiloh Creek in Morehouse Parish (MP 118). Shiloh Creek maintains Class C and D fish populations which produce between 60 and 120 pounds per acre of fish, and has a reduced rough and forage fish fauna as compared to Class A and B streams (U.S. Department of Agriculture 1979a). White and spotted bass, crappies, flathead catfish, and redear sunfish would be significantly reduced in numbers. Bluegill and channel catfish would be present but would display poor growth and condition characteristics.

The Proposed Action would cross Bayou Bartholomew (MP 1199) in Morehouse Parish. The state of Louisiana has classified this portion of

Table 44 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE PROPOSED ACTION AND MARKET ALTERNATIVE THROUGH LOUISIANA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 3=Scenic river)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| Shiloh Creek | 1182 | P | Morehouse |
| UT Ouachita River | 1185 | I | Morehouse |
| Hog Slough | 1187 | I | Morehouse |
| Bayou de Butte | 1191 | P | Morehouse |
| UT Ouachita River | 1192 | I | Morehouse |
| UT Ouachita River | 1193 | I | Morehouse |
| UT Ouachita River | 1195 | I | Morehouse |
| Bayou Bartholomew[1,3] | 1199 | P | Morehouse |
| UT Bayou Bartholomew | 1201 | I | Morehouse |
| UT Bayou Bartholomew | 1205 | I | Ouachita |
| UT Black Bayou Lake | 1207 | I | Ouachita |
| Gourd Bayou | 1214 | I | Ouachita |
| UT Gourd Bayou | 1217 | I | Ouachita |
| UT Youngs Bayou | 1219 | P | Ouachita |
| Petticoat Bayou | 1224 | P | Ouachita |
| Petticoat Bayou | 1224.5 | P | Ouachita |
| Petticoat Bayou | 1225 | P | Ouachita |
| Prairie Bayou | 1226 | I | Ouachita |
| Halfway Bayou | 1228 | I | Ouachita |
| UT Halfway Bayou | 1228.5 | I | Ouachita |
| UT Bayou Lafourche | 1234 | I | Caldwell |
| Ouachita River[1] | 1239 | P | Caldwell |
| UT Ouachita River | 1244 | I | Caldwell |
| UT Black Bayou | 1247 | I | Caldwell |
| UT Black Bayou | 1249 | I | Caldwell |
| UT Black Bayou | 1252 | I | Caldwell |
| UT Black Bayou | 1255 | I | Caldwell |
| UT Black Bayou | 1256 | I | Caldwell |
| Black Bayou | 1257 | P | Caldwell |
| Chickasaw Creek | 1261 | P | LaSalle |
| Delaney Branch Tarven Creek | 1262 | I | LaSalle |
| UT Tarven Creek | 1263 | I | LaSalle |
| UT Cow Creek | 1269 | P | LaSalle |
| Bayou Funny Louis | 1270 | P | LaSalle |
| UT Bayou Funny Louis | 1271 | P | LaSalle |
| UT Trout Creek | 1277 | I | LaSalle |
| UT Catahowla Lake | 1279.5 | I | LaSalle |
| Kitterlin Creek | 1285 | P | LaSalle |
| UT Kitterlin Creek | 1286 | P | LaSalle |
| UT Kitterlin Creek | 1287 | P | LaSalle |
| Little River[1,3] | 1288 | P | LaSalle |
| UT Little River | 1290 | I | Grant |
| UT Little River | 1290.5 | I | Grant |

Table 44 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 3=Scenic river)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| UT Little River | 1291 | I | Grant |
| UT Flagon Bayou | 1295 | P | Rapides |
| Flagon Bayou | 1298 | I | Rapides |
| Red River | 1308 | P | Rapides |
| Chatlin Lake Canal | 1310 | P | Rapides |
| Unnamed stream | 1313 | P | Rapides |
| Unnamed stream | 1314 | P | Rapides |
| Unnamed stream | 1315 | P | Rapides |
| Bayou Boeuf[1] | 1317 | P | Rapides |
| Bayou Boeuf & Cocodrie Diversion Channel[1] | 1319 | P | Rapides |
| UT Beaver Creek | 1324 | I | Rapides |
| UT Cocodrie Lake | 1327 | I | Rapides |
| Spring Creek[1,3] | 1330 | P | Rapides |
| Little Spring Creek | 1332 | P | Rapides |
| UT Little Spring Creek | 1333 | P | Rapides |
| Clear Creek | 1334 | P | Rapides |
| McKemb Branch Bayou Cocodrie | 1335 | P | Rapides |
| Bayou Cocodrie[1,3] | 1337 | P | Evangeline |
| UT Bayou Cocodrie | 1338.5 | P | Evangeline |
| UT Cypress Creek | 1341 | P | Evangeline |
| Cypress Creek | 1342 | P | Allen |
| Morris Branch Beaver Creek | 1343 | P | Allen |
| Beaver Creek | 1345 | P | Allen |
| UT Castor Creek | 1355 | I | Allen |
| UT Calcasieu River | 1356 | I | Allen |
| Bayou Blue | 1363 | I | Allen |
| Unnamed bayou | 1364 | P | Allen |
| Unnamed bayou | 1364.5 | P | Allen |
| Unnamed bayou | 1366 | P | Allen |
| UT Calcasieu River | 1368 | P | Allen |
| UT Calcasieu River | 1369 | P | Allen |
| UT Calcasieu River | 1371 | P | Allen |
| UT Calcasieu River | 1372 | P | Allen |
| Kinder Ditch | 1375 | P | Allen |
| Gum Bayou | 1376 | P | Jefferson Davis |
| Serpent Bayou | 1381 | P | Jefferson Dvais |
| Serpent Bayou | 1383 | P | Jefferson Davis |
| Serpent Bayou | 1383.5 | P | Jefferson Davis |
| Serpent Bayou | 1384 | P | Jefferson Davis |
| Unnamed canal | 1386 | P | Jefferson Davis |
| Calcasieu River[1] | 1390 | P | Calcasieu |
| UT Calcasieu River | 1393 | P | Calcasieu |
| Goldsmith Canal | 1396 | P | Calcasieu |
| UT Little Indian Bayou | 1397 | P | Calcasieu |
| Indian Bayou | 1400 | P | Calcasieu |
| W. Fork Calcasieu River | 1402 | P | Calcasieu |

Bayou Bartholomew as an official Scenic stream . However, it is designated as a Class "C" and "D" fishery, like Shiloh Creek, discussed above.

Invertebrates which would be expected to inhabit Shiloh Creek and Bayou Bartholomew would include various mussels, aquatic worms (Oligochaeta), midges (Chironomidae), and other aquatic insect species.

Streams which have been classified as A and B fisheries be crossed by the Proposed Action include Chickasaw Creek (MP 1261), Bayou Funny Louis (MP 1270), Kitterlin Creek (MP 1285), and Little River (MP 1289), all of which are located in La Salle Parish. Additionally, Little River (MP 1289) has been classified a state Scenic stream . Fisheries characteristics of Class A and B streams have been described in Section 2.A.3, above.

The final stream in the Ouachita basin which would be crossed by the Proposed Action corridor is Flagon Bayou in Rapides Parish (MP 1298). Flagon Bayou has been designated Class C and D regarding its indigenous fish fauna and the characteristics of this classification were presented in this section, above.

Atchafalaya River Basin. The Atchafalaya River basin is a low-lying alluvial floodplain and borders the lower Mississippi River. The mainstem and its tributaries are characterized by willow-covered shorelines, turbid waters, and moderate to fast current (U.S. Army Corps of Engineers 1976a).

Four fish habitats were identified in Atchafalaya basin waters by the U.S. Army Corps of Engineers (1976a): (1) mainstem river and tributaries, (2) interior lakes, (3) sluggish flowing bayous and cypress-tupelo swamp, and (4) floodplain areas along protection levees.

Fishes known from the Atchafalaya River basin are listed in Table 45. The fishery resources of the basin are among its most important natural assets.

Four major benthic habitats exist in the Atchafalaya River basin: (1) rivers and moderately fast-flowing tributaries characterized by hard clay to sandy substrates, (2) bayous and slow-moving location canals with soft clay-organic substrates, (3) swamps, typified by peat substrates, and (4) lakes, characterized by soft clay-organic substrates (U.S. Army Corps of Engineers 1976a).

Main river and tributary channel habitat provides the least productive benthic habitat in the basin with clay substrates dominated by the burrowing mayflies *Tortopus* sp. and *Pentagenia* sp. Other substrates are dominated by aquatic worms.

Bayou and canal habitats are characterized by slow current velocities and substrates of soft clays and organic detritus. Tubificids, midges and scuds dominate this type of habitat (U.S. Army Corps of Engineers 1976a).

Swamp substrate has little or no clay and a preponderance of organic materials. The swamp benthic community includes larval phantom midges (*Chaoborus*), worms, midges and fingernail clams.

Lake substrates are characterized by a mixture of soft clay and fine sand substrates with some organic detritus. The dominant benthic organisms in this habitat are midge larvae (*Coelotanypus*) and the snail (*Amnicola*). Other abundant species include tubificids, isopods and sphaeriid clams (U.S. Army Corps of Engineers 1976a).

The fish fauna of the floodplain areas along the protection levees is the most diverse of the four available habitat types, identified above. Some species, in fact, have only been found in these floodplain areas.

Table 45 FISHES OF THE ATCHAFALAYA RIVER BASIN (U.S. ARMY CORPS OF ENGINEERS 1976a)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| *Polyodon spathula* | Paddlefish |
| *Lepisosteus oculatus* | Spotted gar |
| *Lepisosteus osseus* | Longnose gar |
| *Lepisosteus platostomus* | Shortnose gar |
| *Lepisosteus spatula* | Alligator gar |
| *Amia calva* | Bowfin |
| *Alosa chrysochloris* | Skipjack herring |
| *Dorosoma cepedianum* | Gizzard shad |
| *Dorosoma petenense* | Threadfin shad |
| *Hiodon alosoides* | Goldeye |
| *Anchoa mitchilli* | Bay anchovy |
| *Esox americanus vermiculatus* | Grass pickerel |
| *Cyprinis carpio* | Carp |
| *Hybognathus hayi* | Cypress minnow |
| *Hybognathus nuchalis* | Silvery minnow |
| *Hybopsis aestivalis* | Speckled chub |
| *Hybopsis storeriana* | Silver chub |
| *Notemigonus crysoleucas* | Golden shiner |
| *Notropis atherinoides* | Emerald shiner |
| *Notropis blennius* | River shiner |
| *Notropis buchanani* | Ghost shiner |
| *Notropis fumeus* | Ribbon shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis maculatus* | Taillight shiner |
| *Notropis potteri* | Chub shiner |
| *Notropis shumardi* | Silverband shiner |
| *Notropis texanus* | Weed shiner |
| *Notropis venustus* | Blacktail shiner |
| *Notropis volucellus* | Mimic shiner |
| *Opsopoeodus emiliae* | Pugnose minnow |
| *Pimephales vigilax* | Bullhead minnow |
| *Carpiodes carpio* | River carpsucker |
| *Minytrema melanops* | Spotted sucker |
| *Ictiobus bubalus* | Smallmouth buffalo |
| *Ictiobus cyprinellus* | Bigmouth buffalo |
| *Ictalurus furcatus* | Blue catfish |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus natalis* | Yellow bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus gyrinus* | Tadpole madtom |
| *Pylodictis olivaris* | Flathead catfish |
| *Aphredoderus sayanus* | Pirate perch |

Table 45 (concluded)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| *Strongylura marina* | Atlantic needlefish |
| *Fundulus chrysotus* | Golden topminnow |
| *Lucania parva* | Rainwater killifish |
| *Gambusia affinis* | Mosquitofish |
| *Heterandria formosa* | Least killifish |
| *Poecilia latipinna* | Sailfin molly |
| *Labidesthes sicculus* | Brook silverside |
| *Membras martinica* | Rough silverside |
| *Menidia audens* | Mississippi silverside |
| *Syngnathus scovelli* | Gulf pipefish |
| *Morone chrysops* | White bass |
| *Morone mississippiensis* | Yellow bass |
| *Morone saxatilis* | Striped bass |
| *Centrarchus macropterus* | Flier |
| *Chaenobryttus gulosus* | Warmouth |
| *Elassoma zonatum* | Pygmy sunfish |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis humilis* | Orangespotted sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Lepomis marginatus* | Dollar sunfish |
| *Lepomis megalotis* | Longear sunfish |
| *Lepomis microlophus* | Redear sunfish |
| *Lepomis punctatus* | Spotted sunfish |
| *Lepomis symmetricus* | Bantam sunfish |
| *Micropterus salmoides* | Largemouth bass |
| *Pomoxis annularis* | White crappie |
| *Pomoxis nigromaculatus* | Black crappie |
| *Etheostoma asprigene* | Mud darter |
| *Etheostoma chlorosomum* | Bluntnose darter |
| *Etheostoma fusiforme* | Swamp darter |
| *Etheostoma gracile* | Slough darter |
| *Etheostoma proeliare* | Cypress darter |
| *Percina caprodes* | Logperch |
| *Aplodinotus grunniens* | Freshwater drum |
| *Mugil cephalus* | Striped mullet |
| *Mugil curema* | White mullet |
| *Microgobius gulosus* | Clown goby |
| *Trinectes maculatus* | Hogchoker |

They include the cypress minnow, weed shiner, black bullhead, grass pickerel, bantam sunfish, pygmy sunfish, flier, and swamp darter (U.S. Army Corps of Engineers 1976a).

Most of the other fishes are believed to inhabit all four types of habitat during at least a portion of their life histories.

At least 18 fish species are marketed commercially from the basin; the most important are the catfish, buffalo, and drum.

The Atchafalaya basin crayfish market is an important one providing more than 90% of the total annual state yield, along with the adjoining coastal marsh.

The Proposed Action corridor would enter the basin in Rapides Parish (approximately MP 1310). At approximately MP 1315 the Boyce Lateral slurry line originates and extends northwest to the Boyce site (Table 46). Also at MP 1315 the New Roads Lateral originates and extends southeast to the New Roads delivery site (Table 47). From the New Roads site the Wilton Extension slurry line would carry the slurry to Wilton site (Table 48).

None of the streams or rivers which would be crossed by the Boyce Lateral, New Roads Lateral, or Wilton Extension slurry lines have been designated natural or scenic rivers or maintain fisheries of regional importance. A portion of the Wilton Extension would lie within the Mississippi River drainage. The biota of the lower Mississippi River is described in Section 2.C.5, below.

The Proposed Action main slurry line, however, would cross Spring Creek (MP 1330) and Bayou Cocodrie (MP 1337), both of which have been designated natural and scenic rivers by the State of Louisiana. The biological resources of these streams are similar to those described for the Atchafalaya basin in general as described in this section, above.

Table 46 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE BOYCE LATERAL THROUGH LOUISIANA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| Diversion Channel | 0.5 | P | Rapides |
| Diversion Channel | 5 | P | Rapides |
| Unnamed bayou | 5 | P | Rapides |
| Middle Bayou | 9.5 | P | Rapides |
| UT Bayou Boeuf | 11 | P | Rapides |
| UT Bayou Boeuf | 11.5 | P | Rapides |
| UT Bayou Boeuf | 12 | P | Rapides |
| Bayou Rapides | 15 | P | Rapides |
| UT Bayou Rapides | 18 | I | Rapides |
| UT Fish Lake | 19 | I | Rapides |
| Bayou Jean de Jean | 22 | P | Rapides |

Table 47 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE NEW ROADS LATERAL THROUGH LOUISIANA

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 2=404 permit required)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| UT Chatlin Lake Canal | 3 | P | Rapides |
| UT Chatlin Lake Canal | 6 | P | Rapides |
| UT Chatlin Lake Canal | 7.5 | P | Rapides |
| UT Chatlin Lake Canal | 10.5 | P | Rapides |
| Bayou Clear | 23 | P | Avoyelles |
| UT Bayou Rouge | 27 | P | Avoyelles |
| UT Bayou Rouge | 34 | P | Avoyelles |
| UT Black Water Bayou | 35.5 | P | Avoyelles |
| UT Bayou Rouge | 36.5 | P | St. Laundry |
| Bayou des Glaises Diversion[2] Channel | 40 | P | St. Laundry |
| Bayou Jack | 42 | P | St. Laundry |
| UT Bayou Jack | 45 | P | St. Laundry |
| UT Bayou Rouge | 47 | P | St. Laundry |
| Bayou Rouge | 48.5 | P | St. Laundry |
| UT Bayou Rouge | 50 | P | St. Laundry |
| UT Bayou Rouge | 52 | P | St. Laundry |
| UT Bayou Rouge | 53 | P | St. Laundry |
| Atchafalaya River[1] | 54 | P | Pointe Coupee |
| Johnson Bayou | 56 | P | Pointe Coupee |
| Cowhead Bayou | 57.5 | P | Pointe Coupee |
| Bayou Fordouche | 58.5 | P | Pointe Coupee |
| Bayou Fordouche[2] | 59 | P | Pointe Coupee |
| UT Bayou Portage | 59.5 | P | Pointe Coupee |
| UT Bayou Portage | 60.5 | P | Pointe Coupee |
| UT Bayou Portage | 61.5 | P | Pointe Coupee |
| Bayou Barre | 63.5 | P | Pointe Coupee |

Table 48 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE WILTON EXTENSION THROUGH LOUISIANA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| False River Canal | 4 | P | Pointe Coupee |
| The Chenal | 7.5 | P | Pointe Coupee |
| Stumpy Bayou | 9 | I | Pointe Coupee |
| UT Grand Bayou | 10.5 | P | West Baton Rouge |
| UT Grand Bayou | 12 | P | West Baton Rouge |
| UT Grand Bayou | 15 | P | West Baton Rouge |
| UT Choctaw Bayou | 19 | P | West Baton Rouge |
| UT Choctaw Bayou | 22 | P | West Baton Rouge |
| Gulf Intercoastal Waterway Port Allen Canal[1] | 23 | P | West Baton Rouge |
| Choctaw Basin Canal | 24 | P | West Baton Rouge |
| UT Bayou Baurbeaux | 26.5 | P | West Baton Rouge |
| UT Bayou Baurbeaux | 28.5 | P | West Baton Rouge |
| UT Bayou Baurbeaux | 29.5 | P | West Baton Rouge |
| Bayou Baurbeaux | 30 | P | West Baton Rouge |
| UT Wilbert Canal | 31.5 | P | Iberville |
| Wilbert Canal | 32 | P | Iberville |
| Plaquemine Bayou | 34.5 | P | Iberville |
| Plaquemine Bayou[1] | 35 | P | Iberville |
| UT Bayou Butte | 37.5 | P | Iberville |
| Bayou Butte | 38 | P | Iberville |
| Bayou Gould | 40.5 | P | Iberville |
| Bayou Tigre | 41.5 | P | Iberville |
| Bayou Sigur | 49 | P | Iberville |
| UT Bayou Sigur | 49.5 | P | Ascension |
| Bayou Bijou | 52 | P | Ascension |
| Bayou Lafourche[1] | 54 | P | Ascension |
| Bayou Verret | 56 | P | Ascension |
| UT Bayou Verret | 57.5 | P | Ascension |
| UT Bayou Verret | 59.5 | P | St. James |
| UT Bayou Verret | 60.5 | P | St. James |
| UT Bayou Verret | 61 | P | St. James |
| UT Bayou Verret | 61.5 | P | St. James |
| UT Bayou Verret | 62 | P | St. James |
| UT Bayou Verret | 63 | P | St. James |
| UT Bayou Verret | 63.5 | P | St. James |
| UT Bayou Verret | 64 | P | St. James |
| Unnamed Bayou | 65 | P | St. James |
| Unnamed Bayou | 65.5 | P | St. James |
| Mississippi River[1] | 66 | P | St. James |

Calcasieu River Basin. The Proposed Action enters the Calcasieu River basin at approximately MP 1341 and remains in the basin to its terminus at the Lake Charles delivery terminal. There are no natural and scenic rivers or especially biologically sensitive rivers in the basin which would be crossed by the slurry line.

Streams and rivers of the Calcasieu basin are characterized by riffles with coarse sand, and deep pools (Louisiana Wildlife and Fisheries Commission 1967). There exists a wide habitat diversity for fish and invertebrates as a result of partially buried snags and logs originating from early logging operations. The riparian vegetation consists of mixed pine-hardwood overhangs.

Fishes which have been collected from the Calcasieu basin are listed in Table 49. Blacktail shiner, mimic shiner, topminnows, scaly sand darter and cypress darter are believed to be the most abundant fishes.

The invertebrate fauna is dominated by dense and diverse populations of various crayfishes, beetles, flies, worms, caddisflies, mayflies, stoneflies, dragonflies and damselflies (Louisiana Wildlife and Fisheries Commission 1967).

## 2.A.4 DEWATERING PLANTS

### Ponca City Site

The Ponca City Site would be situated in the Red Rock Creek drainage near the creek's confluence with the Arkansas River. According to aerial coverage photographs (1:40,000 scale), the area is agricultural. Red Rock Creek was rated as a high-priority fishery resource (Class II) by the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conser-

Table 49 FISHES COLLECTED FROM THE CALCASIEU RIVER BASIN (LOUISIANA WILDLIFE AND FISHERIES COMMISSION 1967)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| *Icthyomyzon gagei* | Southern brook lamprey |
| *Dorosoma cepedianum* | Gizzard shad |
| *Esox americanus vermiculatus* | Grass pickerel |
| *Notemigonus crysoleucas* | Golden shiner |
| *Notropis fumeus* | Ribbon shiner |
| *Notropis sabinae* | Sabine shiner |
| *Notropis texanus* | Weed shiner |
| *Notropis umbratilis* | Redfin shiner |
| *Notropis venustus* | Blacktail shiner |
| *Notropis volucellus* | Mimic shiner |
| *Minytrema melanops* | Spotted sucker |
| *Moxostoma poecilurum* | Blacktail redhorse |
| *Ictalurus natalis* | Yellow bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus fumebris* | Black madtom |
| *Noturus gyrinus* | Tadpole madtom |
| *Noturus nocturnus* | Freckled madtom |
| *Fundulus notatus* | Blackstripe topminnow |
| *Fundulus olivaceus* | Blackspotted topminnow |
| *Gambusia affinis* | Mosquitofish |
| *Aphredoderus sayanus* | Pirate perch |
| *Centrarchus macropterus* | Flier |
| *Lepomis gulosus* | Warmouth |
| *Elassoma zonatum* | Pygmy sunfish |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Lepomis megalotis* | Longear sunfish |
| *Lepomis microlophus* | Redear sunfish |
| *Lepomis punctatus* | Spotted sunfish |
| *Micropterus salmoides* | Largemouth bass |
| *Pomoxis nigromaculatus* | Black crappie |
| *Ammocrypta vivax* | Scaly sand darter |
| *Etheostoma chlorosomum* | Bluntnose darter |
| *Etheostoma gracile* | Slough darter |
| *Etheostoma proeliare* | Cypress darter |
| *Percina maculata* | Blackside darter |
| *Percina sciera* | Dusky darter |
| *Percina shumardi* | River darter |
| *Labidesthes sicculus* | Brook silverside |

vation (1978). Red Rock Creek drains directly into the Arkansas River. The biology of the Arkansas River and many of its tributaries was described in Section 2.A.3, above.

Pryor Site

The Pryor site would be situated in the Neosho River basin between Ft. Gibson Reservoir and Lake Hudson. According to aerial photographs (1:40,000 scale), the Pryor dewatering facility would be located on urban and built-up lands (Pryor Power Plant Site). The Pryor dewatering facility would be located in the Four Mile Creek sub-basin. Wallen (1958) collected gizzard shad, bullheads, largemouth bass, sunfish, minnows and shiners from Four Mile Creek. The existing environment of the Neosho basin (Fort Gibson Reservoir Area) was previously discussed in Section 2.1.3.4, above.

Muskogee Site

The Muskogee Site would be located adjacent to the Arkansas River below the confluence of the Neosho and Verdigris River. According to aerial photographs (1:40,000 scale), the Muskogee Site is mostly agriculture. Generally, this portion of the Arkansas River would be expected to contain fishable populations of channel and flathead catfish, buffalo, carpsucker, gar, shad and various species of minnows and shiners. Striped bass spawn in portions of the Arkansas River (see Section 2.1.3.5).

Independence Site

The Independence Site would be located on the White River and the area's aquatic biology was previously described in Section 2.1.3.5 of this report.

## White Bluff Site

The White Bluff Site would be located adjacent to the Arkansas River south of Little Rock, Arkansas. According to aerial photographs (1:40,000 scale), the White Bluff Site is urban and built-up lands (White Bluff Power Plant Site). This stretch of the Arkansas River probably supports catfish, buffalo, carpsucker, gar, shad and various minnows and shiners.

## Boyce Site

The Boyce Site would be located in the Red River drainage, northwest of Alexandria, Louisiana. The Boyce Dewatering Facility would drain into Lake Castor. Standing crops of fish occurring in Louisiana impoundments are, on the average, much lower than the standing crops of fish occurring in other types of Louisiana habitat (Lambou 1959). Non-predaceous species comprise over 80 percent (by weight) of Louisiana impoundment fish populations. Representative, non-predaceous fishes include various sunfish, pirate perch, gizzard and threadfin shad, suckers and bullheads. Predaceous members of Louisiana impoundment ichthyofaunas include bass, crappie, pickerel, gar, channel and flathead catfish and bowfin (Lambou 1959).

Most Louisiana impoundments are used extensively for recreation (Lambou 1959). Combined, these impoundments support a considerable amount of sport fishing.

## New Roads Site

The New Roads dewatering site would be located adjacent to the Mississippi River. According to aerial photographs (1:40,000), the New Roads Dewatering Facility would be located on urban and built-up lands (New Roads Power Plant Site). The aquatic biology of the lower Mississippi River is discussed in Section 2.C.5 of this report.

Wilton Site

The Wilton Site would be located on the west side of the Mississippi River southeast of Donaldsville, Louisiana. The Wilton Dewatering Site is primarily agricultural lands with some oak-hickery forest also present. See Section 2.3.5 of this report for a description of the aquatic resources of the lower Mississippi River.

Lake Charles Site

The Lake Charles Site would be located near the Calcasieu River east of Lake Charles, Louisiana. The Lake Charles Dewatering Site is presently southern pine-hardwood forest. Fishes present in the area probably include gar, bowfin, shad, minnows, shiners, suckers, sunfish and drum (Douglas 1974).

### 2.A.5 ANCILLARY FACILITIES

Ancillary Facilities including transmission towers and power lines would probably be located in the drainages described under the various Proposed Action project components described in Sections 2.1.1, 2.1.2, 2.1.3, and 2.1.4, above. Site specific locations of these components were not available during the production of this report.

## 2.B MARKET ALTERNATIVE

### 2.B.1 COAL SLURRY PREPARATION PLANTS

The Coal Slurry Preparation Plants which would be utilized in processing coal for the Market Alternative would be located in the same areas as those listed for the Proposed Action. The existing environments at those plants are described in Section 2.A.1 of this report.

2.B.2 WATER SUPPLY SYSTEM

The Market Alternative water supply system would be the same as that described for the Proposed Action, and the aquatic biota of the area were described in Section 2.A.2 of this report.

2.B.3 COAL SLURRY PIPELLINE AND PUMP STATIONS

Wyoming

North Antelope Slurry Gathering Line.

The aquatic biota occuring in streams and rivers which would be crossed by the North Antelope Slurry Gathering Line were described in Section 2.A.3.

North Rawhide Slurry Gathering Line.

The aquatic biota occurring in streams which would be crossed by the North Rawhide Slurry Gathering Line were described in Section 2.A.3 of this report.

Coal Slurry Pipelines and Pump Stations.

The Market Alternative pipeline corridor through Wyoming is the same corridor described for the Proposed Action in Section 2.A.3 of this report.

Nebraska

The Market Alternative pipeline corridor through Nebraska is the same corridor described for the Proposed Action in Section 2.A.3 of this report.

Kansas

From north to south the Market Alternative through Kansas would cross the following drainage basins:

- Upper Republican River Basin
- Solomon River Basin
- Saline River Basin
- Smoky Hill River Basin
- Little Arkansas River Basin
- Walnut River Basin
- Caney River Basin

Upper Republican River Basin. The Market Alternative would enter Kansas in the Upper Republican River basin east of Highway 83. Streams and rivers which would be traversed by the Market Alternative through Kansas appear in Table 50. The first permanent stream which would be crossed by the Market Alternative in this basin would be Sappa Creek (MP 13). Near the proposed crossing Sappa Creek is between 7 and 9 feet wide with an average depth of 0.5 feet. The stream substrate is soft, rippled mud with some mud bars exposed along the shorelines. Banks are steep (between 15 and 25 feet). Annual grasses grow near the stream in places. Fireweed and nettles dominate the midbank vegetation (Kansas Forestry, Fish and Game Commission 1977a) Some large elm, cottonwood and boxelder on top of the banks provide stream shading. Aquatic vegetation is lacking in this stretch of Sappa Creek, although in other reaches of the creek duckweed and filamentous green algae were found to be abundant during the 1977 Kansas Forestry, Fish and Game survey. Aquatic invertebrates in Sappa Creek include clams, chironomids, dytiscids, snails, back swimmers, water striders, leeches, dragonfly larvae, water boatmen, gyrinids and amphipods (Kansas Forestry, Fish and Game Commission 1977a). Near the proposed crossing only fathead minnows, black bullheads and an occasional carp are present. Little angling opportunity exists in this stretch of Sappa Creek.

Table 50 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE MARKET ALTERNATIVE THROUGH KANSAS
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UP=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Beaver Creek | 2 | I | Decatur |
| UT Beaver Creek | 5 | I | Decatur |
| UT Beaver Creek | 5.5 | I | Decatur |
| UT Beaver Creek | 7 | I | Decatur |
| UT Sappa Creek | 8 | I | Decatur |
| UT Sappa Creek | 8.5 | I | Decatur |
| UT Sappa Creek | 9 | I | Decatur |
| UT Sappa Creek | 11 | I | Decatur |
| Sappa Creek | 13 | P | Decatur |
| UT Sappa Creek | 14 | I | Decatur |
| UT Sappa Creek | 16 | I | Decatur |
| UT Sappa Creek | 17 | I | Decatur |
| UT Sappa Creek | 18 | I | Decatur |
| UT Spring Branch Sappa Creek | 19 | I | Decatur |
| Spring Branch Sappa Creek | 19.5 | I | Decatur |
| Long Branch Sappa Creek | 21 | I | Decatur |
| UT Long Branch Sappa Creek | 22.5 | I | Norton |
| UT Long Branch Sappa Creek | 23 | I | Norton |
| UT Long Branch Sappa Creek | 25 | I | Norton |
| UT Long Branch Sappa Creek | 25.5 | I | Norton |
| UT Long Branch Sappa Creek | 26 | I | Norton |
| UT Norton Reservoir | 27 | I | Norton |
| UT Norton Reservoir | 27.5 | I | Norton |
| UT Norton Reservoir | 28 | I | Norton |
| UT Norton Reservoir | 29 | I | Norton |
| UT Norton Reservoir | 30 | I | Norton |
| UT Norton Reservoir | 31 | I | Norton |
| UT Norton Reservoir | 32 | I | Norton |
| UT Norton Reservoir | 32.5 | I | Norton |
| UT Norton Reservoir | 33 | I | Norton |
| UT Norton Reservoir | 35 | I | Norton |
| UT Prairie Dog Creek | 37 | I | Norton |
| Prairie Dog Creek | 38 | P | Norton |
| UT Prairie Dog Creek | 39 | I | Norton |
| UT Prairie Dog Creek | 40 | I | Norton |
| UT Prairie Dog Creek | 40.5 | I | Norton |
| Big Thunder Creek | 49 | I | Norton |
| UT N. Fork Solomon River | 51 | I | Norton |
| N. Fork Solomon River | 55 | P | Norton |
| UT N. Fork Solomon River | 57 | I | Norton |
| UT N. Fork Solomon River | 58 | I | Norton |
| UT N. Fork Solomon River | 59 | I | Norton |

Table 50 (continued)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT N. Fork Solomon River | 59.5 | I | Phillips |
| UT N. Fork Solomon River | 60 | I | Phillips |
| UT N. Fork Solomon River | 61 | I | Phillips |
| UT Bow Creek | 61.5 | I | Phillips |
| Bow Creek | 63 | P | Phillips |
| Bow Creek | 63.5 | P | Phillips |
| Bow Creek | 64 | P | Rooks |
| UT Bow Creek | 64.9 | I | Rooks |
| UT S. Fork Solomon River | 69 | I | Rooks |
| UT S. Fork Solomon River | 69.5 | I | Rooks |
| UT S. Fork Solomon River | 70 | I | Rooks |
| UT S. Fork Solomon River | 71 | I | Rooks |
| UT S. Fork Solomon River | 74 | I | Rooks |
| Ash Creek | 77 | I | Rooks |
| UT Ash Creek | 79 | I | Rooks |
| S. Fork Solomon River | 81 | P | Rooks |
| UT S. Fork Solomon River | 81.5 | I | Rooks |
| Box Elder Creek | 82 | I | Rooks |
| Robbers Roost | 85 | I | Rooks |
| Elm Creek | 88 | I | Rooks |
| UT Medicine Creek | 92 | I | Rooks |
| UT Medicine Creek | 92.5 | I | Rooks |
| UT Medicine Creek | 94 | I | Rooks |
| UT Medicine Creek | 96 | I | Rooks |
| UT Paradise Creek | 97 | I | Rooks |
| UT Paradise Creek | 98 | I | Rooks |
| UT Paradise Creek | 100 | I | Rooks |
| UT Paradise Creek | 102 | I | Rooks |
| UT Paradise Creek | 103 | I | Rooks |
| Paradise Creek | 105 | P | Osborne |
| UT Paradise Creek | 107 | I | Osborne |
| Paradise Creek | 109 | P | Osborne |
| Paradise Creek | 109.5 | P | Osborne |
| Paradise Creek | 110 | P | Osborne |
| Paradise Creek | 110.5 | P | Osborne |
| Paradise Creek | 111 | P | Osborne |
| UT Paradise Creek | 111.5 | I | Russell |
| UT Paradise Creek | 112.5 | I | Russell |
| UT Paradise Creek | 113 | I | Russell |
| Paradise Creek | 114 | P | Russell |
| Paradise Creek | 114.5 | P | Russell |
| UT Paradise Creek | 116 | I | Russell |
| UT Paradise Creek | 116.5 | I | Russell |
| Paradise Creek | 118 | P | Russell |

Table 50 (continued)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary) 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Paradise Creek | 120 | I | Russell |
| UT Paradise Creek | 121.5 | I | Russell |
| UT Paradise Creek | 123 | I | Russell |
| UT Saline River | 123.5 | I | Russell |
| Saline River[2] | 124 | P | Russell |
| UT Saline River | 124.5 | I | Russell |
| UT Saline River | 125 | I | Russell |
| UT Saline River | 128 | P | Russell |
| UT Saline River | 129 | I | Russell |
| UT Saline River | 130.5 | I | Russell |
| UT Wilson Lake | 133 | I | Russell |
| UT Wilson Lake | 134 | I | Russell |
| UT Wilson Lake | 135 | I | Russell |
| UT Smoky Hill River | 136 | I | Russell |
| UT Smoky Hill River | 137 | I | Russell |
| UT Smoky Hill River | 138 | I | Russell |
| UT Smoky Hill River | 138.5 | I | Russell |
| UT Smoky Hill River | 140 | I | Russell |
| Unnamed stream | 142 | I | Russell |
| UT Smoky Hill River | 144 | I | Russell |
| Smoky Hill River | 144.5 | P | Russell |
| UT Smoky Hill River | 148 | I | Ellsworth |
| Blood Creek | 149 | P | Ellsworth |
| Wolf Creek | 153 | I | Ellsworth |
| UT Smoky Hill River | 155 | I | Ellsworth |
| UT Smoky Hill River | 157 | I | Ellsworth |
| UT Turkey Creek | 158 | I | Ellsworth |
| Turkey Creek | 159 | I | Ellsworth |
| UT Oxide Creek | 160 | I | Ellsworth |
| Oxide Creek | 161 | P | Ellsworth |
| UT Ash Creek | 163 | I | Ellsworth |
| UT Ash Creek | 163.5 | I | Ellsworth |
| UT Ash Creek | 164 | I | Ellsworth |
| UT Ash Creek | 164.5 | I | Ellsworth |
| UT Ash Creek | 165 | I | Ellsworth |
| UT Ash Creek | 167 | I | Ellsworth |
| UT Thompson Creek | 168 | I | Ellsworth |
| UT Thompson Creek | 169 | I | Ellsworth |
| UT Thompson Creek | 171 | I | Ellsworth |
| UT Thompson Creek | 171.5 | I | Ellsworth |
| UT Little Arkansas River | 172 | I | Ellsworth |
| UT Little Arkansas River | 173 | I | Ellsworth |
| UT Little Arkansas River | 173.5 | I | Ellsworth |
| UT Little Arkansas River | 175 | I | Rice |
| UT Little Arkansas River | 175.5 | I | Rice |
| UT Little Arkansas River | 176 | I | Rice |

Table 50 (continued)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Little Arkansas River | 177 | I | Rice |
| Horse Creek | 180 | I | Rice |
| UT Horse Creek | 180.5 | I | Rice |
| UT Little Arkansas River | 183 | P | Rice |
| UT Little Arkansas River | 184 | I | Rice |
| UT Little Arkansas River | 187 | I | Rice |
| N. Fork Little Arkansas River | 188 | I | Rice |
| Lone Tree Creek | 192 | P | McPherson |
| UT Wolf Creek | 194 | I | McPherson |
| Wolf Creek | 195 | P | McPherson |
| UT Blaze Fork Little Arkansas River | 198 | I | McPherson |
| UT Blaze Fork Little Arkansas River | 199 | I | McPherson |
| UT Blaze Fork Little Arkansas River | 203 | I | McPherson |
| Blaze Fork Little Arkansas River | 204 | P | McPherson |
| UT Turkey Creek | 213 | I | Harvey |
| Turkey Creek | 213.5 | P | Harvey |
| Turkey Creek | 214 | P | Harvey |
| Turkey Creek | 215 | P | Harvey |
| Sand Creek | 216 | P | Harvey |
| UT Little Arkansas River | 216.5 | I | Harvey |
| Black Kettle Creek | 219 | P | Harvey |
| West Emma Creek | 225 | P | Harvey |
| Middle Emma Creek | 227 | P | Harvey |
| Sand Creek | 231 | P | Harvey |
| E. Fork Jester Creek | 235 | P | Harvey |
| UT Jester Creek | 236 | I | Harvey |
| W. Fork Chisholm Creek | 240 | I | Sedgwick |
| Chisholm Creek | 241 | I | Sedgwick |
| UT Chisholm Creek | 242.5 | I | Sedgwick |
| Whitewater Creek | 249 | I | Sedgwick |
| Dry Creek | 255 | P | Butler |
| Dry Creek | 255.5 | P | Butler |
| Dry Creek | 256 | P | Butler |
| UT Dry Creek | 257 | I | Butler |
| Dry Creek | 264 | P | Butler |
| Little Walnut River | 268 | P | Butler |
| Muddy Creek | 271 | P | Butler |
| UT Rock Creek | 274 | I | Butler |
| UT Rock Creek | 276 | I | Butler |
| UT Rock Creek | 277 | I | Butler |
| Rock Creek | 278 | P | Butler |
| Dutch Creek | 280 | P | Cowley |
| UT Dutch Creek | 281 | I | Cowley |

Table 50 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| Timber Creek | 285 | P | Cowley |
| UT Timber Creek | 286 | I | Cowley |
| Grouse Creek | 291.5 | P | Cowley |
| UT Grouse Creek | 294 | P | Cowley |
| UT Otter Creek | 295 | I | Cowley |
| Otter Creek | 301 | P | Cowley |
| UT Otter Creek | 304 | I | Cowley |
| Caney River | 308 | P | Chautauqua |
| Turkey Creek | 309 | P | Chautauqua |
| Spring Branch | 311 | I | Chautauqua |
| Grant Creek | 316 | P | Chautauqua |
| UT Sycamore Creek | 318 | I | Chautauqua |
| Sycamore Creek | 319 | I | Chautauqua |

Long Branch of Sappa Creek would be traversed by the Market Alternative at MP 21 on the Decatur-Norton county line. For the most part, Long Branch is biologically similar to Sappa Creek. This creek ranges between 6 and 9 feet in width and averages nearly 8 inches in depth near the proposed crossing (Kansas Forestry, Fish and Game Commission 1977a). Heavy silt loads have filled most of the stream's pools and the stream banks are steep to vertical in places. Tall native grasses and goldenrod are prevalent on the steep bank slopes and along the waterline. The underbrush is composed of some ragweed and sunflower. Woody riparian vegetation on the upper banks is composed of large dead cottonwoods, elms, and boxelder, however, little stream shading is provided. Filamentous algae and vascular plants are present in Long Branch. Aquatic invertebrates in Long Branch include snails, crayfish, dytiscid beetles, clams, water boatmen and water striders. The Kansas Forestry, Fish and Game Commission collected fathead minnows and black bullheads from Long Branch and reported little angling opportunity exists in the stream. Occasionally, black bullheads are taken.

Prairie Dog Creek would be traversed by the Market Alternative (MP 38) just below the Norton Reservoir dam. Prairie Dog Creek, near the proposed crossing, is relatively wide. Mean depth is 6 inches while the stream width varies between 10 and 17 feet (Kansas Forestry, Fish and Game Commission 1977a). The stream banks of Prairie Dog Creek are relatively steep and usually covered with native grasses and forbs. The mud and sand streambed is littered with debris. Overstory is scarce and dominated by cottonwoods and boxelder. Willows and elm are less abundant. Smartweed, fireweed, tall ragweed, and native midgrasses comprise the dense understory. According to the Kansas Forestry, Fish and Game Commission, filamentous green algae are probably abundant in the summer months. Aquatic invertebrates from this portion of Prairie Dog Creek include

mayfly and dragonfly larvae, clams, snails, back swimmers, water striders, chironomids and water boatmen. Due to agricultural cultivation, associated pollutants severely affect Prairie Dog Creek. Dewatering from extensive irrigation withdrawals downstream from Norton Reservoir have resulted in significant fish habitat loss. Angling is limited to deeper pools and to periods of increased flow. Black bullheads and channel catfish are taken occasionally. Other gamefish present in Prairie Dog Creek are largemouth bass and green sunfish. Nonsport fishes include sand shiners, fathead minnows, red shiners, orangethroat darters and creek chubs (Kansas Forestry, Fish and Game Commission 1977a).

Solomon River Basin. The Market Alternative would enter the Solomon River basin at approximately MP 43. Most of the streams crossed in this basin are intermittent tributaries to the North and South Forks of the Solomon River. The North Fork would be traversed at approximately MP 55 (Table 50). Near the proposed crossing, the North Fork ranges between 6 and 10 feet wide with an average depth of only 4 inches. The gently sloping stream banks are covered with goldenrod, common ragweed, and sunflowers. The sparse overstory is represented by cottonwood, ash, and boxelder (Kansas Forestry, Fish and Game Commission 1977b). The streambed is composed of fine sand and is mostly uniform in configuration. Aquatic invertebrates present in this stretch of the North Fork Solomon River include water striders, water boatmen, dragonflies, mayflies, caddisflies, snails, and leeches. Duckweed is abundant in some of the quiet backwater areas. Associated species such as rushes and cattails are also present. Fishing success in this stretch of the North Fork is poor, at best (Kansas Forestry, Fish and Game Commission 1977b). Channel catfish are taken at log drifts and pools during and after periods of heavy rainfall. Green sunfish and black bullheads may be taken rarely. Nonsport fishes present in the North Fork include creek chubs, red shiners, sand shiners, fathead minnows, stonerollers, orangethroat darters and plains killifish.

Bow Creek, also permanent, would be traversed by the Market Alternative at approximately MP 441 on the Phillips-Rooks county line. According to the Kansas Forestry, Fish and Game Commission (1977b) Bow Creek would be the largest stream crossed by the proposed Market Alternative in the Solomon Basin. The proposed crossing is upstream from Kirwin Reservoir which infuences the indigenous fish populations of Bow Creek. Bow Creek varies between 15 and 40 feet in width with an average depth of 1.5 feet near the proposed crossing. An October discharge of 27 cfs was recorded in 1975. The creek meanders through pasture and cropland. The stream banks are steep and moderately high. Ground cover is affected by grazing while the overstory is sparse and dominated by mature cottonwoods and willows. Filamentous green algae are abundant in Bow Creek. Aquatic invertebrates present in this section of Bow Creek include whirlygig beetles, crayfish, snails, damselfly and dragonfly nymphs, mayfly nymphs, and water striders. During periods of high water channel catfish, drum and black bullheads migrate upstream from Kirwin Reservoir and provide some angling opportunities (Kansas Forestry, Fish and Game Commission 1977b).

Harvestable carp also occur in Bow Creek. River carpsucker, white suckers, creek chubs, sand shiners, fathead minnows, and stonerollers represent the nonsport fishes present in this section of Bow Creek. Further downstream channel catfish fishing can be good.

The final permanent stream which would be traversed by the Market Alternative in the Solomon River basin in Kansas would be the South Fork Solomon River (MP 459) in Rooks County. The crossing occurs immediately downstream from the Webster Reservoir Dam and upstream from Stockton, Kansas. Near the proposed crossing the South Fork varies between 10 and 30 feet in width with an average depth of 5 inches. A November discharge of 5 cfs was recorded in 1974 (Kansas Forestry, Fish and Game Commission 1977b). The South Fork Solomon River is influenced by irrigation releases from Webster Reservoir which modifies the streambed for approximately 3 months of the year (Kansas Forestry, Fish and Game

Commission 1977b). During these periods of increased discharge, in 1974, stream flow varied between 50 and 180 cfs. These elevated discharges create stream conditions which are not present the remaining 9 months of the year. Stream banks are relatively steep and almost barren. The absence of riparian overstory precludes stream shading. The streambed is mostly gravel and sand with an occasional sand bar present. Some attached filamentous algae occur along portions of the streambed. Sedges and cattails are also present. Although game fish are present in this stretch, most are too small to harvest. Apparently, the bulk of gamefish come from Webster Reservoir irrigation discharges. Green sunfish and small channel catfish are the primary game species although black crappie are also present. Forage species occurring in the South Fork near the proposed crossing include creek chubs, red shiners, sand shiners, bluntnose minnows, stonerollers, plains killifish and orangethroat darters (Kansas Forestry, Fish and Game Commission 1977b).

Saline River Basin. The Market Alternative would enter the Saline River basin at approximately MP 97 in Rooks County, Kansas. Permanent stream crossings would occur on Paradise Creek and the Saline River just upstream from its confluence with Wilson Lake.

The Market Alternative would cross Paradise Creek twice. The first crossing occurs in the creek's headwaters (MP 105). The streambed in the head waters consists of mud and the stream bands are silt (Kansas Fish and Game Commission 1979a). Mature green ash, American elm, boxelder, walnut, and black mulberry shades the stream. Understory forbs include poison hemlock, sunflower, giant ragweed and goldenrod. Apparently, no aquatic vegetation exists. A few water striders, damselfly and dragonfly larvae, mayfly nymphs and crayfish comprise the aquatic invertebrate fauna. During periods of increased runoff green sunfish and black bullheads are taken occasionally. Fathead minnows comprise the bulk of the forage fish population. During periods of long drought, Paradise Creek becomes intermittent.

The second crossing would occur in the downstream portion of Paradise Creek (MP 496). The streambed is wide and consists of gravelly sand over hard clay. Small trees are scattered along the stream banks and the creek is afforded little shading. No aquatic vegetation occurs in this section of Paradise Creek. Hexagenia spp. nymphs are common on submerged debris. Progomphus spp. and beetle larvae (Gyrinus spp.) are also present (Kansas Fish and Game Commission 1979a). Two types of snails, Physa and Lynmaea are common. Angling in this section of Paradise Creek is relatively poor except during periods of heavy runoff. Largemouth bass, channel catfish, and black bullheads are the primary game species taken. This portion of Paradise Creek serves mainly as a minnow fishery. Creek chubs, suckermouth minnows, red shiners, sand shiners, fathead minnows, bluntnose minnows, stonerollers, and plains killifish are abundant.

The final permanent stream crossing in this basin would be the Saline River (MP 502) in the upstream portions of Wilson Lake, north of Russell, Kansas. Near the proposed crossing, the Saline River averages 28 feet in width with a mean depth of 6 inches. An October discharge of 23 cfs was recorded in 1975 (Kansas Fish and Game Commission 1979a). The streambed is primarily sandy gravel and fine sand. Parts of the Saline River run alongside steep rock bluffs. The few willows growing along the stream's margin provide limited shading. Very few aquatic insects occur in this stretch of the Saline River, although a wide diversity exists in the benthic fauna. Mayfly nymphs, dragonfly nymphs and caddisfly larvae occur on submerged debris. Beetles and water striders occur in quieter areas. No aquatic vegetation is present. Angling success in this section of the Saline River is relatively good. White bass spawning runs provide excellent fishing for short periods in the spring. Fall fishing for channel catfish, flathead catfish and black bullheads is also good. Nonsport fishes in this section of the Saline River include gizzard shad, creek chubs, suckermouth minnows, red shiners, sand shiners, fathead minnows, bluntnose minnows, stonerollers, plains killifish and logperch.

Smoky Hill River Basin. The Market Alternative would enter the Smoky Hill River drainage basin at MP 137 and would cross the Smoky Hill River at MP 144.5, upstream from Kanopolis Reservoir near the Russell-Ellsworth county line. The Smoky Hill River in Russell and Ellsworth counties is relatively wide (up to 100 feet) with an average depth near 2 feet. The streambed is composed of sand and silt, except in holes where silt and debris accumulate. The low areas surrounding the Saline River are cultivated while some of the higher areas are mostly native prairie. Some forest may also be present. Sand bars are present in portions of the river. Crayfish are common in the river and fragile paper mussels are also present (Kansas Fish and Game Commission 1979b). Chironomids, damselflies and mayflies are common in appropriate habitat. The Smoky Hill River maintains a good population of harvestable channel catfish, flathead catfish, drum and carp. Spring spawning runs of white bass from Kanopolis Reservoir provides good, although seasonally limited, fishing. Black bullheads and bluegill are also taken. Forage fishes present in the river include gizzard shad, suckermouth minnows, red shiners, sand shiners, bluntnose minnows, stonerollers, stonecat and plains killifish. Several of the intermittent tributaries traversed by the Market Alternative probably serve as fish habitat and spawning areas for the riverine species during high water.

Little Arkansas River Basin. The Market Alternative would enter the Little Arkansas River basin at approximately MP 174 in Ellsworth County just north of Genesco, Kansas. Approximately 12 miles of the route would parellel the Little Arkansas River in northern Rice County. Generally, this stretch supports some channel catfish, flathead and bullhead production, but the small size of the stream and lack of access restricts the angling success. Green sunfish, orangespotted sunfish, river carpsucker, carp, red shiners and fathead minnows occur in this stretch of the Little Arkansas River (Kansas Forestry, Fish and Game Commission 1977d). Turkey Creek would be traversed by the Market Alternative at MP 213.5, 214 and 215 in Harvey County. Turkey Creek is typical of most streams in the drainage. The creek is wide (average width is

about 20 feet) and average depth is nearly 3 feet. The stream bed consists of mud and sand (Kansas Forestry, Fish and Game Commission 1977d). A July discharge of 47 cfs was recorded during the Kansas Forestry, Fish and Game survey in 1975. The overstory consists of ash, mulberry, cottonwood, willows, and elm. Apparently, Turkey Creek has a history of oil and salt water pollution which limits its value as a fishery. Fishes indiginous to the stream include channel catfish, green sunfish, black bullheads, drum and red shiners. The stream banks are steep on both sides.

The Market Alternative would approach the Little Arkansas River at MP 215 near the confluence of Turkey and Sand Creek. This portion of the Little Arkansas River varies between 40 and 60 feet in width with an average depth of 20 inches. The streambed is mud and silt and the banks are steep. This portion of the Little Arkansas River meanders through areas of tall timber including native maple, cottonwood, elm, mulberry, hackberry, ash and willow. The understory consists mostly of brome and foxtail due to the shading from the overstory (Kansas Forestry, Fish and Game Commission 1977d). Aquatic vegetation apparently is lacking. In the portion of the Little Arkansas River above Halsted, Kansas, angling success for channel and flathead catfish is good. Most of the catfish are taken on set lines. The extensive fallen timber in the stream provides excellent catfish habitat. Panfish present in this stretch of the Little Arkansas River include black bullheads, orangespotted sunfish and green sunfish. Drum, carp, river carpsucker, red shiners gizzard shad and fathead minnows comprise the remainder of the indigenous ichthyofauna.

Black Kettle Creek would be traversed by the Market Alternative at MP 597 in Harvey County. Sections of this stream are relatively wide, between 20 and 40 feet in some stretches, while other portions of the stream are narrow and shallow. The streambed consists mainly of mud and silt (Kansas Forestry, Fish and Game Commission 1977d). Stream banks vary between steep and gently sloping. An overstory of cottonwood, elm,

Osage orange, mulberry and maple shades most of the stream. The understory is sparse and consists mostly of smooth brome, ragweed, blue grama and native grasses. Crayfish (Orconectes spp.) are numerous in Black Kettle Creek. The majority of the fish caught are bullheads, white crappie and green sunfish. Carp, red shiners and golden shiners are also present.

West and Middle Emma creeks would be traversed at MP 603 and 605 respectively. Fishes present in the Emma Creek drainage include channel catfish, green sunfish, black bullheads, orangespotted sunfish, carp, sand and red shiners and fathead minnows (Kansas Forestry, Fish and Game Commission 1977d). Fishing success in Emma Creek is limited by low flows and high turbidity. The deeper pools formed by beaver dams yield some harvestable bullheads and sunfish.

Sand Creek would be traversed by the proposed Market Alternative at MP 609 in Harvey County, just north of Sedgwick, Kansas. Sand Creek varies between 15 and 22 feet in width with an average depth of 2 feet near the proposed crossing. A July discharge of 25.6 cfs was recorded by the Kansas Forestry, Fish and Game Commission in 1975. The steep stream banks are composed of mud and silt. The streambed is primarily sand. The riparian vegetation consists of willow and cottonwoods, but canopy cover is lacking. The Kansas Forestry, Fish and Game Commission (1977d) reported several fish kills in Sand Creek due to runoff from the Newton sewage plant and the Santa Fe Railroad yard. Most angling in Sand Creek is limited to carp, bullheads, channel catfish and sunfish. Forage populations consist mainly of red and sand shiners, bluntnose minnows, and mosquitofish.

The final permanent stream which would be traversed by the Market Alternative in the Little Arkansas River drainage basin would be the East Fork of Jester Creek (MP 285). Jester Creek has been adversely affected by channelization and siltation and consequently a relatively unproductive substrate of silt, mud and shifting sand exists. The

stream banks are steep and only a small portion of the stream is shaded. Dense patches of arrowhead are common in some areas. The aquatic invertebrate fauna consists of crayfish (Orconectes sp.), giant waterbugs, predacious diving beetles, water striders and stoneflies. The fish fauna includes green sunfish, orangespotted sunfish, gizzard shad, golden shiners, red and sand shiners, bluntnose minnows, mosquitofish and stonerollers.

Walnut River Basin. The Market Alternative would enter the Walnut River drainage basin at approximately MP 245 in Sedgwick County, northeast of Wichita.

The first stream which would be traversed by the Market Alternative in this basin is Dry (Indianola) Creek at MP 255 and 264. The crossings would occur upstream from Santa Fe Lake. A low water dam in Sedgwick County and the Santa Fe Lake Dam provide good access to Dry Creek and consequently the stream receives heavy fishing pressure. The banks vary in height from 8 to 15 feet and the average stream width is about 30 feet. Average stream depth in Dry Creek is 12 inches (Kansas Forestry, Fish and Game Commission 1977e). Silt and rubble comprise the majority of the streambed. Large rocks, trash and scrap metal are common in the streambed and on the banks. The overstory consists of walnut, elm, mulberry, bur oak, boxelder, hackberry, honey locust, and Osage orange. The understory is mainly buck brush, goldenrod, and other annual weeds. Smartweed and water primrose comprise the bulk of the aquatic vegetation in Dry Creek. Crayfish (Orconectes spp.) and whirlygig beetles are common in the stream. Water striders are also present. Anglers take a wide variety of game fish from this section of Dry Creek including sunfish, bullheads, crappie, channel catfish, bass, drum, carp, and flathead catfish. Both largemouth and spotted bass are present in the creek, however, the latter is more common. Nonsport species present in Dry Creek include golden and red shiners, and fathead minnows.

Little Walnut Creek would be traversed by the Market Alternative at MP 646 in Butler County. Little Walnut Creek is relatively wide and shallow. Average width near the proposed crossing is 60 feet while the average depth is about 3 feet. Riffles and pools are present in this portion of Little Walnut Creek. The streambed is mostly limestone rubble in the riffle areas and sand, silt and bedrock in the runs. Bank heights very between 2 and 16 feet. The overstory, consisting of bur oak, willow, cottonwood, walnut, pecan, elm, locust, sycamore, boxelder, and Osage orange, partially shades the creek. The understory consists of elderberry, annual weeds and grasses. Aquatic vegetation is lacking. The Kansas Forestry, Fish and Game Commission (1977e) reported caddisflies, whirlygig beetles, stoneflies, riffle beetles and mayflies common in this stream.

A list of fish species collected from Little Walnut Creek by the Kansas Forestry, Fish and Game Commission (1977e) is presented in Table 51. Anglers take bullheads, channel and flathead catfish, bass, crappie, sunfish and carp from this portion of Little Walnut Creek.

Muddy Creek would be traversed by the Market Alternative at MP 649 in Butler County, northeast of Douglas, Kansas. This stream averages 48 feet in width and 3 feet in depth. The streambed consists of limestone bedrock, with some silt and gravel overlying the bedrock. The riparian overstory consists of elm, Osage orange, black willow, hackberry, bur oak, ash, black locust, walnut and redbud. Poison ivy, wild grape, coralberry and goldenrod dominate the understory. Small, scattered stands of water willow occur along the streambed. Mayflies, stoneflies, caddisflies, dytiscids, water scavenger beetles and water striders dominate the aquatic invertebrate fauna. Muddy Creek receives moderate fishing pressure and the anglers take mostly bullheads, crappie and sunfish. Channel catfish, carp, golden redhorses, bigmouth buffalo, drum, gizzard shad, red shiners and orangethroat darters are also present (Kansas Forestry, Fish and Game Commission 1977e).

Table 51 FISHES PRESENT IN THE SECTION OF LITTLE WALNUT CREEK WHICH WOULD BE TRAVERSED BY THE MARKET ALTERNATIVE ROUTE, BUTLER COUNTY, KANSAS (KANSAS FORESTRY, FISH AND GAME COMMISSION 1977e)

PREDACEOUS

Spotted bass *(Micropterus punctatus)*
Largemouth bass *(Micropterus salmoides)*

CATFISH

Channel catfish *(Ictalurus punctatus)*
Flathead catfish *(Pylodictis olivaris)*
Black bullhead *(Ictalurus melas)*

PANFISH

Green sunfish *(Lepomis cyanellus)*
Orangespotted sunfish *(Lepomis humilis)*
Longear sunfish *(Lepomis megalotis)*
White crappie *(Pomoxis annularis)*

MARKETABLE AND OTHER SPORTFISH

River carpsucker *(Carpiodes carpio)*
Carp *(Cyprinus carpio)*
Golden redhorse *(Moxostoma erythrurum)*

NONSPORT FISH

Gizzard shad *(Dorosoma cepedianum)*
Bluntnose minnow *(Pimephales notatus)*
Red shiner *(Notropis lutrensis)*
Suckermouth minnow *(Phenacobius mirabilis)*
Stoneroller *(Campostoma anomalum)*
Mosquitofish *(Gambusia affinis)*
Bigeye shiner *(Notropis boops)*
Orangethroat darter *(Etheostoma spectabile)*
Logperch *(Percina caprodes)*

Rock Creek would be traversed by the Market Alternative at approximately MP 278 on the Butler-Cowley county line. Rock Creek varies between 24 and 55 feet in width and averages 24 inches in depth near the proposed crossing. An August discharge of 3 cfs was recorded from Rock Creek by the Kansas Forestry, Fish and Game Commission in 1975. The streambed consists of rock, clay and gravel. The banks are steep; between 4 and 18 feet.

The stream bank canopy consists of hackberry, walnut, honey locust, cottonwood, American elm, black willow, bur oak, Osage orange, ash, Kentucky coffeetree, redbud and boxelder. Native grasses dominate the understory. Arrowhead and smartweed occur along sections of the stream bank. Common aquatic invertebrates in the Rock Creek include caddisflies, damselflies, whirlygig beetles, water striders and hellgrammites (*Corydalus* spp.). Fishing success in Rock Creek is fair and the stream receives moderate fishing pressure. Sunfish, bullheads, bass and carp are the most commonly taken sport fish. Spotted and largemouth bass are both present in the South Fork although spotted bass are much more common. Other species present in the creek include channel and flathead catfish, river carpsucker, golden redhorses, longnose gar, bluntnose and suckermouth minnows, golden and red shiners, stonerollers, orangethroat darters and logperch.

Dutch Creek would be crossed at approximately MP 280 of the Market Alternative. Dutch Creek varies between 25 and 82 feet in width and averages 15.4 inches in depth near the proposed pipeline crossing. The streambed is composed of silt over bedrock in pools, bedrock and rubble in the riffles and rocks and bedrock in the runs (Kansas Forestry, Fish and Game Commission 1977e). Banks are between 3 and 9 feet high with slopes varying from 0 to 90 degrees.

Attached filamentous algae, smartweed, rushes and watercress dominate the aquatic flora. The overstory consists of sycamore, willow, American elm, Osage orange, black walnut, boxelder, redbud,

honey locust, hackberry, and cottonwood. However, only a small percentage of the stream is shaded. The understory along Dutch Creek includes poison ivy, wild grape, buck brush, brome, sideoats grama, foxtail, bermuda grass, goats beard, prairie coneflower, giant ragweed, ironweed, green briar, and false indigo. Aquatic invertebrates collected by the Kansas Forestry, Fish and Game Commission (1977 e) from Dutch Creek are listed in Table 52. The angler use of Dutch Creek is low but fisherman have fair success taking channel catfish, bullheads, largemouth and spotted bass. Other sport fishes or marketable species present in Dutch Creek include white crappie, longear, orangespotted and green sunfish, bigmouth buffalo, longnose gar, carp, golden redhorses and river carpsucker. The forage fauna consists of red shiners, bluntnose minnows, gizzard shad, redfin shiners, stonerollers, and logperch.

The final permanent stream which would be traversed in the Walnut River basin by the Market Alternative would be Timber Creek (MP 285) in Cowley County. Near the proposed crossing, Timber Creek varies between 36 and 41 feet in width and the average depth is 22.8 inches. A July discharge of 13 cfs was recorded from Timber Creek by the Kansas Forestry, Fish and Game Commission (1977 e) in 1975. Timber Creek's streambed consists of gravel and clay. The stream banks are steep and vary between 5 and 10 feet in height. Aquatic vegetation is limited to filamentous algae. The riparian overstory consists of boxelder, honey locust, black walnut, hackberry, sycamore, willow, American elm, Osage orange, bur and pin oak, Kentucky coffeetree, cottonwood and maple. Buck brush, poison ivy, wild grape, elderberry, currant, wild lettuce, giant ragweed, ironweed, brome and foxtail dominate the understory. The stream channel receives about 30% shading (Kansas Forestry, Fish and Game Commission 1977 e). Caddisflies, mayflies, and water scavenger beetles are abundant in this stretch of Timber Creek. Whirlygig beetles, water striders, stoneflies, and dragonfly nymphs are less abundant but still common. Mussels present in Timber Creek include fingernail clams and the fragile paper mussel (*Leptodea fragilis*). Crayfish (*Orconectes* spp.)

Table 52 RELATIVE ABUNDANCE OF AQUATIC INVERTEBRATES COLLECTED FROM DUTCH CREEK NEAR THE PROPOSED CROSSING OF THE MARKET ALTERNATIVE (KANSAS FORESTRY, FISH AND GAME COMMISSION 1977e)

ABUNDANT

Dobsonfly larva
Mayfly
Caddisfly

COMMON

Fingernail clam
Damselfly
Water strider
Whirlygig beetle
Dragonfly
Fish fly *(Sialis* spp.*)*

UNCOMMON

Scud *(Hyalella azteca)*
Bloodworm
Water scavenger beetle
Fragile paper shell mussel *(Leptodea fragilis)*

are common while a few snails may also occur. The watershed dam creating Winfield City Lake prevents upstream fish migration into Timber Creek from the Walnut River. Timber Creek. upstream from Winfield City Lake provides a fairly high quality fishery. Sport fishes present in Timber Creek include spotted bass, channel catfish, black crappie, bullheads, green sunfish and carp. Other sunfish, golden redhorses, red and golden shiners, bluntnose minnows, redfin shiners, logperch, stonerollers, and orangethroat darters comprise the remaining portion of Timber Creek's ichthyofauna.

Caney River Drainage Basin. The final drainage which would be traversed by the Market Alternative in Kansas is the Caney River basin. The fishes of the Caney River basin in Chautauqua, Cowley and Elk counties, Kansas were surveyed by Metcalf (1959). The following discussion is from his descriptions.

Grouse Creek (MP 291.5) is a small intermittent stream which receives heavy use from cattle. The substrate is mud and rubble. The average width near the proposed crossing is 10 feet while the depth averages 8 inches. During the summer months the streambed is covered with tangled growths of *Sorgum halepense*.

Otter Creek (MP 301) has an average width and depth of 10 feet and 15 inches, respectively, near the proposed crossing. The stream is characterized by pools interspersed with shallow rubble riffles. The ichthyofauna of Otter Creek consists of red shiners, rosyface shiners, redfin shiners, bluntnose minnows, stonerollers, black bullheads, yellow bullheads, logperch, orangethroat darters, spotted bass and green sunfish.

The Caney River would be traversed by the Market Alternative at MP 308 in Kansas. A list of fishes which could occur in the stretch of the Caney River which would be traversed by the Market Alternative appears in Table 53.

Table 53 FISH OF THE CANEY RIVER, KANSAS (METCALF 1959)

| Scientific Name | Common Name |
|---|---|
| FAMILY LEPISOSTEIDAE | GARS |
| *Lepisosteus osseus* | Longnose gar |
| FAMILY CLUPEIDAE | HERRINGS |
| *Dorosoma cepedianum* | Gizzard shad |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Campostoma anomalum* | Stoneroller |
| *Notropis boops* | Bigeye shiner |
| *Notropis buchanani* | Ghost shiner |
| *Notropis camurus* | Bluntface shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis umbratilis* | Redfin shiner |
| *Notropis volucellus* | Mimic shiner |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Pimephales vigilax* | Bullhead minnow |
| *Pimephales tenellus* | Slim minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Ictiobus cyprinellus* | Bigmouth buffalo |
| *Ictiobus niger* | Black buffalo |
| *Moxostoma erythrurum* | Golden redhorse |
| *Moxostoma duquesnei* | Black redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Pylodictis olivaris* | Flathead catfish |
| FAMILY POECILIIDAE | LIVEBEARERS |
| *Gambusia affinis* | Mosquitofish |
| FAMILY ATHERINIDAE | SILVERSIDES |
| *Labidesthes sicculus* | Brook silverside |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Micropterus salmoides* | Largemouth bass |
| *Micropterus punctatus* | Spotted bass |
| *Pomoxis annularis* | White crappie |
| *Lepomis cyanellus* | Green sunfish |

Table 53 (concluded)

| Scientific Name | Common Name |
|---|---|
| *Lepomis humilis* | Orangespotted sunfish |
| *Lepomis megalotis* | Longear sunfish |
| *Lepomis macrochirus* | Bluegill |
| FAMILY PERCIDAE | PERCHES |
| *Etheostoma spectabile* | Orangethroat darter |
| *Percina copelandi* | Channel darter |
| FAMILY SCIAENIDAE | DRUMS |
| *Aplodinotus grunniens* | Drum |

The Caney River in Chautauqua County, Kansas averages 55 feet in width. The river in the area has both riffles and runs. The substrate is composed of mud and gravel (Kansas Fish and Game Commission 1980). The streambanks range from 0-10 feet in height. The overstory consists of cottonwood, willow, elm, green ash, sycamore, and mulberry. The overstory shades about 70 percent of the stream channel. The understory consists of Indigo bush, wildgrape, Johnson grass, goldenrod, giant ragweed, cockleburr, and sunflower. Filamentous algae and water willow are common.

Abundant aquatic invertebrates present in the Caney River include caddisflies (Hydropsychidae), riffle beetles (Elmidae) and dryopoid beetles. Less abundant aquatic invertebrates are *Corydalus*, mayflies, Gyrinidae, water striders and the following unionid mussels:

floater mussel (*Anodonta grandis*)
plain pocketbook mussel (*Lampsilis ovata*)
deer toe mussel (*Truncilla truncata*)
solid pig-toed mussel (*Pleurobema cordatum catillus*)
fat mucket mussel (*Lampsilis radiata siliquoidea*)

Oklahoma

Streams and rivers which would be traversed by the Market Alternative through Oklahoma are listed in Table 54. The entire route would lie in the Verdigris and Arkansas River Basins. The Market Alternative would traverse the Caney River (MP 324.5), Buck Creek (MP 325) and Pond Creek (MP 329) just upstream from their confluence with Hulah Lake in Osage County. Buck Creek was rated as a highest-value fishery resource (Class I) and Pond Creek as a high-priority fishery resource (Class II) by the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation (1978).

The Hulah Lake region is characterized by long, rolling, northeast-southwest trending ridges. They slope gently to the northwest and rather steeply to the southeast, and are separated by broad, open valleys. The

Table 54 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE MARKET ALTERNATIVE THROUGH OKLAHOMA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 2=404 permit required; 3=Natural and scenic river)

| Stream | MP | Flow | County |
|---|---|---|---|
| Caney River | 324.5 | P | Osage |
| Buck Creek | 325 | P | Osage |
| Pond Creek | 329 | I | Osage |
| Spring Creek | 330 | I | Osage |
| Birch Creek | 333 | I | Osage |
| Mission Creek | 336 | I | Osage |
| UT Mission Creek | 338 | I | Osage |
| UT Buck Creek | 340 | I | Osage |
| UT Butler Creek | 341 | I | Osage |
| UT Turkey Creek | 346 | I | Osage |
| Turkey Creek | 346.5 | I | Osage |
| Sand Creek | 350 | P | Osage |
| Caney River | 353 | P | Washington |
| Caney River | 353.5 | P | Washington |
| Caney River | 354 | P | Washington |
| Caney River | 357 | P | Washington |
| Caney River | 365 | P | Washington |
| Buck Creek | 370 | I | Rogers |
| Rabb Creek | 372 | I | Rogers |
| Fourmile Creek | 377 | P | Rogers |
| Verdigris River[2] | 380 | P | Rogers |
| Dog Creek | 389 | P | Rogers |
| UT Dog Creek | 390 | I | Rogers |
| UT Lake Claremore | 391 | I | Rogers |
| UT Chouteau Creek | 396 | I | Rogers |
| UT Chouteau Creek | 406 | I | Mayes |
| Neosho River[2] | 409 | P | Mayes |
| UT Neosho River | 411 | I | Mayes |
| Snake Creek | 414 | I | Mayes |
| Spring Creek | 415 | P | Mayes |
| Blackbird Creek | 426 | I | Cherokee |
| UT Fourteenmile Creek | 428.5 | I | Cherokee |
| Fourteenmile Creek | 429 | I | Cherokee |
| Double Spring Creek | 432 | I | Cherokee |
| UT Illinois River | 433 | I | Cherokee |
| Illinois River[1,3] | 437 | P | Cherokee |
| Baron Fork[2,3] | 440 | P | Cherokee |
| UT Caney Creek | 445 | P | Cherokee |
| Caney Creek | 447 | P | Cherokee |
| UT Caney Creek | 449 | P | Cherokee |
| UT Caney Creek | 450 | I | Adair |
| UT Caney Creek | 451 | I | Adair |
| UT Sallisaw Creek | 453 | I | Adair |
| Sallisaw Creek | 455 | P | Adair |
| UT Sallisaw Creek | 460 | P | Adair |
| UT Lee Creek | 465 | I | Sequoyah |

Table 54 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE MARKET ALTERNATIVE THROUGH OKLAHOMA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required; 3=Natural and Scenic River).

| Stream | MP | Flow | County |
|---|---|---|---|
| Little Lee Creek | 470 | P | Sequoyah |
| UT Lee Creek | 471 | P | Sequoyah |
| Lee Creek[1,3] | 472 | P | Sequoyah |

valley in which Hulah Lake is located is relatively flat and broad, with well-defined margins. Uplands are not rugged, but in many places descend rather steeply into the main basin area (U.S. Army Corps of Engineers 1975a). Two physiographic areas occur in the region, Cherokee prairies and cross timbers.

There are three basic vegetative types in the vicinity of Hulah Lake. They are tall grass prairie, post-blackjack oak (cross timbers types) and elm-ash-cottonwood type. In 1951, approximately 60 percent of the basin's lands were under cultivation, 21 percent in tall grass prairie, 12 percent in post-blackjack oak (cross timber) type, and 8 percent in elm-ash-cottonwood type. Most of the land which was once in cultivation has been changed to grazing land (U.S. Army Corps of Engineers 1975a).

Elm-ash-cottonwood type lies along the area's streams and in their floodplains. American elm dominates the flood plain woods. Other dominants include slippery elm, sycamore, cottonwood, butternut hickory, shagbark hickory, pawpaw and bur oak. The characteristic species of the understory are blue phlox, four o'clock, smooth yellow violet, sedges, wild petunia, spiderwort, hedge nettle, dead nettle, wild rye, milkweed, lady's thumb, tall bellflower, spike grass, purple meadow rue, white vervian and wingstem (U.S. Army Corps of Engineers 1975a).

The turbidity of Hulah Lake is considered to be above average for lakes in this region of Oklahoma. Turbidity of water is attributable to material suspended in the water column which diminishes the penetration of light.

A large percentage of Hulah Lake is relatively shallow at the normal conservation pool. This situation permits loose sedimentary material such as silt, mud, clay and organic detritus to become suspended in surface waters as a result of wave action affecting the bottom. These suspended solids may have an adverse effect on the fish and other aquatic fauna by causing abrasive injuries; by clogging the respiratory passages; blanketing the lake bottom; and by interfering with the penetration of

light, thereby reducing the amount of primary productivity through a reduction in photosynthesis. The fluctuating water levels and above average turbidity reduces available habitat for aquatic vegetation in Hülah Lake.

Hulah Lake provides a low to moderate quality fishery comprised primarily of largemouth bass, white bass, crappie, channel and flathead catfish, walleye, bullheads, carp, gar, buffalo, bluegill and other sunfish.

The aquatic biota of the remainder of the streams which would be crossed by the Market Alternative through Oklahoma were described in Sections 2.A.3 of this report.

Arkansas

The Market Alternative route through Arkansas would be identical to the route described for the Proposed Action (Section 2.A.3) except for approximately the first 20 miles through the state in Crawford County (Table 54). The Market Alternative route would run approximately 5 miles north of the Proposed Action in this area. The biological characteristics of the streams at crossing locations, however, would be expected to be similar to those described for the same streams in Section 2.A.3, above

Louisiana

The Market Alternative corridor through Louisiana is the same route previously described for the Proposed Action in Section 2.A.3 of this report, except for the Baton Rouge extension to the Baton Rouge delivery terminal (Table 56). The biological characteristics of the streams similar to those crossed by the Baton Rouge extension in the Atchafalaya basin were described in Section 2.A.3, above. The biology of the lower Mississippi River (MP 24) is described in Section 2.C.3, below.

Table 55 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE MARKET ALTERNATIVE THROUGH ARKANSAS
(MP=Approximate pipeline milepost at proposed crossing; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Lee Creek | 477 | P | Crawford |
| UT Lee Creek | 480 | P | Crawford |
| W. Cedar Creek | 483 | P | Crawford |
| Frog Bayou | 488 | P | Crawford |
| Little Frog Bayou | 492 | P | Crawford |
| * | | | |

* From approximately MP 493.5 the Market Alternative slurry pipeline would be identical to the Proposed Action slurry line and would serve the same markets in Arkansas and Louisiana.

Table 56 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE BATON ROUGE EXTENSION THROUGH LOUISIANA.
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | Parish |
|---|---|---|---|
| False River Canal | 4 | P | Pointe Coupee |
| The Chenal | 7.5 | P | Pointe Coupee |
| Stumpy Bayou | 9 | I | Pointe Coupee |
| UT Grand Bayou | 10.5 | P | West Baton Rouge |
| UT Grand Bayou | 12 | P | West Baton Rouge |
| UT Grand Bayou | 15 | P | West Baton Rouge |
| Mississippi River[1] | 24 | P | East Baton Rouge |

## 2.B.4 DEWATERING PLANTS

### Oologah Site

The Oologah dewatering plant would be located adjacent to the Verdigris River. The Oologah Dewatering Site would occupy urban and built-up lands (Oologah Power Plant Site). The biological characteristics of the Verdigris River in the vicinity of the plant were described in Section 2.A.3, above.

### Pryor Site

The potentially affected drainage and its biological characteristics have been identified and described in Sections 2.A.4 and 2.A.3, above.

### Independence Site

The potentially affected drainage and its biological characteristics have been identified and described in Sections 2.A.4 and 2.A.3, above.

### White Bluff Site

The potentially affected drainage and its biological characteristics have been identified and described in Sections 2.A.4 and 2.A.3, above.

### Boyce Site

The potentially affected drainage and its biological characteristics have been identified and described in Sections 2.A.4 and 2.A.3, above.

### New Roads Site

The potentially affected drainage and its biological characteristics have been identified and described in Sections 2.A.4 and 2.A.3, above.

### Baton Rouge Site

The Baton Rouge dewatering plant would be located adjacent to the Mississippi River. The Baton Rouge Dewatering Site would be located on urban and built-up lands. The biological characteristics of the lower Mississippi River are described in Section 2.C.3, below.

### Wilton Site

The potentailly affected drainage and its biological characteristics are identified and described in Sections 2.A.4 and 2.A.3, above.

### Lake Charles Site

The potentially affected drainage and its biological characteristics are identified and described in Sections s.A.4 and 2.A.3, above.

### 2.B.5 ANCILLARY FACILITIES

Ancillary facilities including transmission towers and power lines would be anticipated to be located in the same drainages as described under the various project components in this section. Site specific locations of these components were not available during the production of this report.

## 2.C PIPELINE-BARGE ALTERNATIVE

### 2.C.1 COAL SLURRY PREPARATION PLANTS

The aquatic environment which would be affected by the Coal Slurry Preparation Plants is described in Section 2.A.1.

### 2.C.2 WATER SUPPLY SYSTEM

The Niobrara well field water supply system was discussed in Section 2.A.2 of this report.

2.C.3 COAL SLURRY PIPELINES AND PUMP STATIONS

Wyoming

North Antelope Slurry Gatherine Line.

The streams and rivers which would be affected by the North Antelope Slurry Gathering Line were discussed in Section 2.A.3 of this report.

North Rawhide Slurry Gatherine Line.

The aquatic biota occurring in streams crossed by the North Rawhide Slurry Gathering Line are described in Section 2.A.3.

Coal Slurry Pipelines and Pump Stations.

The Pipeline-Barge Alternative pipeline corridor through Wyoming would be the same route discussed for the Market Alternative through Wyoming (Section 2.B.3).

Nebraska

The Pipeline-Barge Alternative pipeline corridor through Nebraska would be the same route discussed for the Market Alternative through Nebraska (Section 2.B.3).

Kansas

The Pipeline-Barge Alternative pipeline corridor through Kansas would be the same route discussed for the Market Alternative through Kansas (Section 2.B.3).

Oklahoma

The Pipeline-Barge Alternative pipeline corridor through Oklahoma would be the same route discussed for the Market Alternative through Oklahoma (Section 2.B.3).

Arkansas

The portion of the Pipeline-Barge Alternative which would traverse Arkansas between the Arkansas-Oklahoma state line and the White Bluff site crosses through the Arkansas River basin. The aquatic biota of the Arkansas River basin was described in Section 2.A.3 of this report. The remainder of the Pipeline-Barge Alternative slurry line would consist of the Cypress Bend Lateral. Most of the Cypress Bend Lateral would cross streams which flow directly into the lower Mississippi River. Streams and rivers which would be crossed by the Cypress Bend Lateral are listed in Table 57.

Lower Mississippi River Basin. The largest aquatic resource in the Mississippi River is that portion of the mainstem with an average depth greater than 5 feet (U.S. Army Corps of Engineers 1976b). This vast area is inherently low in primary productivity on a per acre basis because of high turbidity. The low productivity, characteristically shifting substrates, and high current velocities combine to support a limited benthic community. The deep main river channel is the habitat of large predaceous fishes, some plankton feeders, and a group of omnivorous species.

A list of fishes occurring in the lower Mississippi River appears in Table 58. One hundred sixty-two species have been identified in the lower Mississippi. Of this number, 114 are freshwater and 48 are marine or estuarine and capable of enduring exposure to varying amounts of fresh water. The following species are common throughout the entire lower river area.

Bowfin
Spotted gar
Gizzard shad
Threadfin shad
Carp
Bigmouth buffalo
Smallmouth buffalo
White crappie
Freshwater drum
Black buffalo
Quillback
River carpsucker
Blue catfish
Flathead catfish
Channel catfish
Yellow bass
Black crappie

Table 57 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE CYPRESS BEND LATERAL THROUGH ARKANSAS
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 1=Section 10 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Love Creek | 0.5 | I | Jefferson |
| UT Eastwood Bayou | 3 | I | Jefferson |
| Eastwood Bayou | 5 | I | Jefferson |
| Caney Bayou | 7 | I | Jefferson |
| Bayou Bartholomew | 13 | I | Jefferson |
| UT Bayou Bartholomew | 18 | I | Jefferson |
| Boggy Bayou | 20 | I | Jefferson |
| UT Bayou Bartholomew | 26.5 | I | Jefferson |
| UT Bayou Bartholomew | 31 | I | Lincoln |
| UT Bayou Bartholomew | 33 | I | Lincoln |
| Turtle Creek | 38 | I | Lincoln |
| Flat Creek | 40 | I | Lincoln |
| Bayou Bartholomew | 45 | P | Lincoln |
| UT Bayou Bartholomew | 48 | P | Lincoln |
| UT Bayou Bartholomew | 49 | P | Lincoln |
| UT Bayou Bartholomew | 49.5 | P | Lincoln |
| UT Bayou Bartholomew | 50.5 | P | Lincoln |
| UT Bayou Bartholomew | 51 | P | Lincoln |
| UT Bayou Bartholomew | 52 | P | Lincoln |
| Little Wagon Bayou | 58 | P | Desha |
| Choctaw Bayou | 59 | P | Desha |
| Little Wagon Bayou | 63 | P | Desha |
| Cypress Creek Channel #19 | 65 | P | Desha |
| Amos Bayou | 67 | P | Desha |
| UT Boggy Bayou | 77 | P | Desha |
| UT Boggy Bayou | 78.5 | P | Desha |
| *Mississippi River[1] | 80 | P | Desha |

* A barge loading facility would be built in the Mississippi River if the Pipeline-Barge Alternative were constructed.

Table 58 FRESHWATER FISHES OCCURRING IN THE LOWER MISSISSIPPI RIVER (U.S. ARMY CORPS OF ENGINEERS 1976b)

| Common Name | Scientific Name |
|---|---|
| Silver lamprey | Ichthyomyzon unicuspis |
| Chestnut lamprey | I. castaneus |
| Southern brook lamprey | I. gagei |
| Lake sturgeon | Acipenser fulvescens |
| Atlantic sturgeon | A. oxyrhynchus |
| Pallid sturgeon | Scaphirhynchus albus |
| Shovelnose sturgeon | S. platorynchus |
| Paddlefish | Polyodon spathula |
| Bowfin | Amia calva |
| Alligator gar | Lepisosteus spatula |
| Longnose gar | L. osseus |
| Spotted gar | L. oculatus |
| Shortnose gar | L. platostomus |
| American eel | Anguilla rostrata |
| Skipjack herring | Alosa chrysochloris |
| Alabama shad | A. alabamae |
| Gizzard shad | Dorosoma cepedianum |
| Threadfin shad | D. petenense |
| Goldeye | Hiodon alosoides |
| Mooneye | H. tergisus |
| Northern pike | Esox lucius |
| Chain pickerel | Esox niger |

Table 58 (continued)

| | |
|---|---|
| Carp | Cyprinus carpio |
| Golden shiner | Notemigonus crysoleucas |
| Speckled chub | Hybopsis aestivalis |
| Flathead chub | H. gracilis |
| Sturgeon chub | H. gelida |
| Gravel chub | H. x-punctatus |
| Sicklefin chub | H. meeki |
| Silver chub | H. storeriana |
| River carpsucker | Carpiodes carpio |
| Highfin carpsucker | C. velifer |
| Golden redhorse | Moxostoma erythrurum |
| Northern redhorse | M. macrolepidotum |
| Spotted sucker | Minytrema melanops |
| Creek chubsucker | Erimyzon oblongus |
| Blue catfish | Ictalurus furcatus |
| Black bullhead | I. melas |
| Channel catfish | I. punctatus |
| Yellow bullhead | I. natalis |
| Brown bullhead | I. nebulosus |
| Flathead catfish | Pylodictis olivaris |
| Stonecat | Noturus flavus |
| Tadpole madtom | N. gyrinus |
| Freckled madtom | N. nocturnus |
| Pirate perch | Aphredoderus sayanus |
| Blackspotted topminnow | Fundulus olivaceous |
| Blackstripe topminnow | F. notatus |
| Mosquitofish | Gambusia affinis |
| Brook silversides | Labidesthes sicculus |
| Mississippi silversides | Menidia audens |
| White bass | Morone chrysops |
| Yellow bass | M. mississippiensis |
| Flier | Centrarchus macropterus |
| Green sunfish | Lepomis cyanellus |
| Warmouth | L. gibbosus |

Table 58 (continued)

| | |
|---|---|
| Orangespotted sunfish | Lepomis humilis |
| Bluegill | L. macrochirus |
| Longear sunfish | L. megalotis |
| Redear sunfish | L. microlophus |
| Spotted bass | Micropterus punctulatus |
| Largemouth bass | M. salmoides |
| Pugnose minnow | Opsopoeodus emiliee |
| Emerald shiner | Notropis atherinoides |
| Spottail shiner | N. hudsonius |
| Silverband shiner | N. shumardi |
| Common shiner | N. cornutus |
| Bigmouth shiner | N. dorsalis |
| Mimic shiner | N. volucellus |
| Spotfin shiner | N. spilopterus |
| Ghost shiner | N. buchanani |
| Taillight shiner | N. maculatus |
| Sand shiner | N. stramineus |
| Ribbon shiner | N. fumeus |
| River shiner | N. blennius |
| Chub shiner | N. potteri |
| Red shiner | N. lutrensis |
| Blacktail shiner | N. venustis |
| Weed shiner | N. texanus |
| Steelcolor shiner | N. shipplei |
| Silvery minnow | Hybognathus nuchalis |
| Plains minnow | H. placitus |
| Cypress minnow | H. hayi |
| Bullhead minnow | Pimephales vigilax |
| Bluntnose minnow | P. notatus |
| Fathead minnow | P. promelas |
| Suckermouth minnow | Phenacobius mirabilis |
| Blue sucker | Cycleptus elongatus |

Table 58 (concluded)

| | |
|---|---|
| Bigmouth buffalo | Ictiobus cyprinellus |
| Smallmouth buffalo | I. bubalus |
| Black buffalo | I. niger |
| Quillback | Carpiodes cyprinus |
| Banatam sunfish | Lepomis symmetricus |
| Spotted sunfish | L. punctatus |
| Pygmy sunfish | Elassoma zonatus |
| White crappie | Pomoxis annularis |
| Black crappie | Pomoxis nigromaculatus |
| Sauger | Stizostedion canadense |
| Walleye | S. vitreum |
| Dusky darter | Percina sciera |
| Logperch | P. caprodes |
| River darter | P. shumardi |
| Stargazing darter | P. uranidea |
| Slenderhead darter | P. phoxocephala |
| Bluntnose darter | Etheostoma chlorosomum |
| Crystal darter | Ammocrypta asprella |
| Western sand darter | A. clara |
| Scaly sand darter | A. virax |
| Speckled darter | Etheostoma stigmatum |
| Harlequin darter | E. histrio |
| Mud darter | E. asprigene |
| Slough darter | E. gracile |
| Cypress darter | E. proelare |
| Freshwater drum | Aplodinotus grunniens |

The area along the channel, averaging less than 5 feet in depth, represents only a limited percentage of the main channel, but is an extremely productive area for all trophic levels. Factors which increase the productivity include reduced current velocity, increased availability of cover, and existence of substrates exposed to sufficient light to allow algal growth. Fishes that may be found in this habitat include minnows, catfishes, carp, carpsucker and sunfishes. Clams, many dipterans and mayflies are some representative invertebrates. River chutes, which may be as shallow as 5 feet but are often deeper, provide good habitat for species requiring continuously moving water, but not strong deep river currents.

Areas of slackwater behind the main channel are very slow moving and shallow, providing important spawning and nursery sites for fishes and abundant food in the form of benthos and plankton. These slackwaters are valuable for both commercial and sport fishing.

Lakes and borrow pits (lentic waters) may be the most productive waters of the basin. While not as diverse in fish species as slack-waters off the main channel, these relatively stable water bodies support large aquatic populations of plants and animals. The growth of higher plants around these waters may reduce phytoplankton growth near the edges; however, the effect is generally minor and shad (gizzard and threadfin) and paddlefish may be supported largely by phytoplankton. The higher plants around these water bodies are also important primary producers in that a significant amount of leaf litter, branches, and other organic matter may wash into these lakes and borrow pits during high water conditions, becoming a source of detritus.

Macrobenthos are generally believed to be scarce in the main river channel. In terms of dominance, the flies (Diptera), mayflies (Ephemer-optera), segmented worms (Oligochaeta), and fingernail clams (sphaeriids) are important components of bottom-fauna. All of these forms are excellent fish foods.

Invertebrate pelagic elements include the river shrimp, populations of which have flourished from time to time in the river but accurate recent data are lacking to define their present extent or status. A list of macroinvertebrates occurring in the lower Mississippi River and its tributaries appears in Table 59.

In contrast to the relatively sparse benthic populations of the main river, flood plain lakes support a rich benthic community. These areas ar particularly productive in numbers of individuals as well as species. Crayfish, aquatic isopods, amphipods (scuds, Gammarus sp.), and the grass shrimp, Palaemonetes sp. are often found in littoral zones of lakes or shallow waters of the mainstem river where they are associated with submerged vegetation. They are abundant and highly desirable food items, readily taken by a variety of fishes.

Rooted and sedentary plants are restricted in the main river channel by high turbidity and velocity as well as widely fluctuating water levels. Many lakes and borrow pits may have luxuriant growths of aquatic vegetation and seeds and vegetative debris may be swept from these areas as well as from tributary streams during high water to maintain a small population in the mainstem river. Common aquatic rooted vegetation is listed in Table 60.

Floating plants, such as duckweed, water meal, water ferns, alligator weed, and water hyacinths, are generally not supported as a resident population in mainstem waters. They do occur in slackwater areas (U.S. Army Corps of Engineers 1976b).

## 2.C.4 DEWATERING PLANTS

### Oologah Site

The potentially affected drainage and its biological characteristics were described in Sections 2.B.4 and 2.A.3, above.

Table 59 BENTHIC MACROINVERTEBRATES OCCURRING IN THE LOWER MISSISSIPPI RIVER (U.S. ARMY CORPS OF ENGINEERS 1976 b)

---

PHYLUM ARTHROPODA

Class Crustacea

Order Isopoda
- Family Asellidae
  - *Lirceus louisinae*
- Family Bopyridae
  - *Probopyrus* sp.
- Family Asellidae
  - *Lirceus* sp.

Order Amphipoda
- Family Talitridae
  - *Hyalella azteca*
- Family Gammaridae
  - *Gammarus fasciatus*

Order Decapoda
- Family Palaemoniidae
  - *Macrobrachium ohione*
  - *Palaemonetes kadiakensis*
- Family Astacidae
  - *Procambarus clarki*
  - *Procambarus blandingi acutus*
  - *Procambarus vioscai*
  - *Cambarellus schufeldi*
  - *Cambarus diogenes diogenes*
  - *Orconectes lancifer*
  - *Orconectes palmeri palmeri*
  - *Orconectes virilis*

Class Insecta

Order Collembola
- Family Isotomidae
  - *Isotoma* sp.
- Family Sminthuridae
  - *Sminthurides* sp.

Order Ephemeroptera
- *Tortopus primus*
- *Oreianthus* sp.
- *Pentagenia vittigera*
- *Hexagenia limbata*
- *Stenonema frontale*
- *Heptagenia* sp.
- *Rhithrogenia* sp.
- *Paraleptophlebia* sp.
- *Tricorythodes* sp.
- *Callibaetis* sp.
- *Centroptilum* sp.
- *Pseudocloeon* sp.
- *Baetis* sp.
- *Ameletus* sp.
- *Baetisca obesa*
- *Isonychia* sp.
- *Caenis* sp. (nymphs)

Order Odonata
- Family Gomphidae
  - *Ophiogomphus* sp.
  - *Gomphus* sp.
  - *Dromogomphus spoliatus*
  - *Dromogomphus spinosus*
  - *Dromogomphus armatus*
  - *Progomphus* sp.
  - *Gomphus viilosipes*
- Family Aeschnidae
  - *Boyeria* sp.
  - *Coryphaeschna ingens*
  - *Aeschna* sp.
  - *Epiaeschna heros*

Table 59 (continued)

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Order Coleoptera
  Family Elmidae
    Macronychus glabratus
    Cylloepus sp.
  Family Dytiscidae
    Hydroporus sp.
    Graphoderus sp.
    Coptotomus sp.
    Cybister sp.
    Dytiscus sp.
    Laccophilus sp.
  Family Gyrinidae
    Dineutus sp.
  Family Haliplidae
    Peltodytes sp.
  Family Hydrophilidae
    Tropisternus sp.
    Laccoblus sp.
    Berosus sp.
  Family Dryopidae
    Dryops sp.
  Family Curculionidae
    unidentified adults

Order Plecoptera
  Family Perlodidae
    Isoperla sp.

Order Trichoptera
  Family Helicopsychidae
    Helicopsyche sp.
  Family Hydroptilidae
    Ochrotitchia sp.
  Family Hydropsychidae
    Hydropsyche orris
    Triaenodes sp.
    Cheumatopsyche sp.
  Family Psychomyidae
    Neuroclipsis sp.
    Unident. psychomyiids

Order Megaloptera
  Family Sialidae
    Sialis sp.
  Family Corydalidae
    Chauloides sp.
    Corydalus cornutus

Family Libellulidae
- *Dythemis* sp.
- *Libellula* sp.
- *Epicordulia* sp.
- *Somatochlora* sp.
- *Macromia* sp.
- *Neurocordulia* sp.
- *Holocordulia* sp.
- *Pachydiplax longipennis*
- *Plathemis lydia*
- *Tetragoneuria* sp.
- *Perithemis domitia*

Family Agrionidae
- *Agrion* sp.

Family Coenagrionidae
- *Enallagma* sp.
- *Ischnura* sp.
- *Argia* sp.
- *Nehallenia* sp.
- *Lestes* sp.
- *Amphiagrion* sp.

Order Hemiptera

Family Pleidae
- *Plea* sp.

Family Hydrometridae
- *Hydrometra* sp.

Family Mesoveliidae
- *Mesovelia* sp.

Family Gerridae
- *Gerris* sp.
- *Trepobates* sp.
- *Rheumatobates* sp.

Family Notonectidae
- *Notonecta* sp.

Family Naucoridae
- *Pelocoris* sp.

Family Nepidae
- *Ranatra* sp.

Family Belostomatidae
- *Belostoma* sp.
- *Lethocerus* sp.

Family Corixidae
- *Trichorixa* sp.
- *Graptocorixa* sp.

Table 59. (continued)

---

Order Diptera
- Family Tipulidae
  - Helius sp.
  - Tipula sp.
- Family Culicidae
  - Aedes sp.
  - Chaoborus sp.
  - Anopheles sp.
  - Culex quinquefasciatus
  - Chaoborus punctipennis
  - Machlonyx sp.
- Family Simuliidae
  - Simulium sp.
- Family Chironomidae
  - Demicrytochironomus sp.
  - Tendipes (Cryptochironomus) fulvus
  - Tendipes (C.) Sp.
  - T. (Dicrotendipes) nemodestus
  - T. (Endochironomus) nigricans
  - T. (Limnochironomus) modestus
  - T. (Tendipes) attenuatus
  - T. (Stichtochironomus) flavicingula
  - Coelotanypus concinnus
  - Coryneura sp.
  - Diamesa sp.
  - Pentapedilum sp.
  - Polypedilum (P.) flavus
  - Metriocnemus sp.
  - Chironomus spp. (larvae and pupae)
  - Spaniotoma sp. (larvae)
  - Cricoptopus spp. (larvae and pupae)
  - Pentaneura monilis
  - Pentaneura sp. (cf. carnea)(pupae)
  - Pentaneura sp. (cf. flavifrons) (pupae)
  - Procladius sp. (cf. culiciformis) (pupae)
  - Tanytarsus sp. (pupa)
  - diamesine pupa
  - unidentified chironomid larvae
- Family Stratiomyiidae
  - Stratiomyia sp.

---

Family Tabanidae
*Chrysops* sp.
*Tabanus* sp.

Family Ceratopogonidae
Unidentified ceratopogonid larva

Class Arachnida

Order Acarina
Unidentified water mites

PHYLUM MOLLUSCA

Class Gastropoda

Family Physidae
*Physa* sp. (adult)
*Physa pomilia*
Family Planorbidae
*Helisoma trivolvis*
*Gyraulus* sp.
Family Lymnaeidae
*Lymnaea* sp.
Family Ancylidae
*Ferrisia* sp.
Family Viviparidae
*Campeloma* sp.
*Viviparus* sp.
Family Pleuroceridae
*Gonoiobasis* sp.
*Pleurocera* sp.
Family Amnicolidae
*Somotogyrus* sp.

Class Pelecypoda

Family Sphaeriidae
*Musculium* sp.
*Sphaerium*
*Eupera* sp.
*Pisidium* sp.

Table 59 (concluded)

Family Cyrenidae
  _Corbicula leana_
  _Corbicula manilensis_
Family Unionidae
  _Lampsilis anodontoides_
  _Margaritifera hembeli_
  _Fusconia missouriense_
  _Arkansia wheeleri_
  _Ptychobranchus occidentalis_
  _Lampsilis streckeri_
  _Dysonomia florentina curtisi_
  _Dysnomia lefevrei_
  _Toxolasma lividumglans_
  _Fusconaia ebenus_
  _Fusconaia undata_
  _Megalonaias gigantea_
  _Amblema peruviana_
  _Quadruia refulgens_
  _Quadrula pustulosa_
  _Quadrula quadrula_
  _Quadrula nodulata_
  _Quadrula metanevra_
  _Tritogonia verrucosa_
  _Lasmigona complanata_
  _Anodonto corpulenta_
  _Anodonta imbecillis_
  _Obliquaria reflexa_
  _Obovaria divaria_
  _Obovaria olivaria_
  _Truncilla truncata_
  _Truncilla donaciformis_
  _Plagiola lincolata_
  _Leptodea fragilis_
  _Leptodea laevissima_
  _Proptera alata_
  _Ligumia recta latissima_
  _Cyclonaias tuberculata granifera_
  _Plethobasus cyphyus_
  _Arcidens confragosus_
  _Alasmidonta marginata_
  _Actinonaias ellipsiformis_
  _Elliptio crassidens_
  _Pleurobema cordatum coccineum_

Table .60 COMMON AQUATIC PLANTS OCCURRING IN THE LOWER MISSISSIPPI RIVER (U.S. ARMY CORPS OF ENGINEERS 1976b)

| | |
|---|---|
| Rooted or Sedentary: | |
| Pickerelweed | *Pontederia cordata* |
| Mud plantain | *Heteranthera dubia* |
| Pondweeds | *Potamogeton* sp. |
| Water-lilly | *Nelumbo lutea* |
| Cow-lilly | *Nymphaea advena* |
| Cattail | *Typha latifolia* |
| Coontail | *Ceratophyllum* sp. |
| Waterweed | *Elodea canadensis* |
| Bladderwort | *Utricularia biflora* |
| Fanwort | *Cabomba caroliniana* |
| Water crowfoot | *Ranunculus delphinifolius* |
| Featherfoil | *Hottonia inflata* |
| Parrot feather | *Myriophyllum brasiliense* |
| Black rush | *Juncus roemerianus* |
| Floating: | |
| Water hyacinth | *Eichornia crassipes* |
| | *Lemna valdiviana* |
| Duckweed | *Lemna minor* |
| | *Spirodela polyrhiza* |
| | *Azolla caroliniana* |
| | *Wolffia columbiana* |
| | *Ricciocarpus natans* |
| Alligator weed | *Alternanthera philoxeroides* |

Pryor Site

The potentially affected drainage and its biological characteristics were described in Sections 2.A.4 and 2.A.3, above.

Independence Site

The potentially affected drainage and its biological characteristics were described in Sections 2.A.4 and 2.A.3, above.

White Bluff Site

The potentially affected drainage and its biological characteristics were identified and described in Sections 2.A.4 and 2.A.3, above.

Cypress Bend Site

The aquatic biota of the lower Mississippi River were described in Section 2.C.3, above.

### 2.C.5 BARGE LOADING FACILITY

The barge loading facility at Cypress Bend would be located on the Mississippi River shorline in Desha County, Arkansas. The existing aquatic resources of the lower Mississippi River were described in Section 2.C.3 of this report.

### 2.C.6 BARGE ROUTE

From the Cypress Bend loading facility barge traffic would serve the Baton Rouge, Wilton and New Roads markets. Barges would travel to these sites via the lower Mississippi River. The aquatic biota of the lower Mississippi River were described in Section 2.C.3 of this report.

## 2.C.7 ANCILLARY FACILITIES

Ancillary facilities including transmission towers and power lines would be anticipated to be located in the same drainages as those described under the various project component headings in this section. Site specific locations of these components were not available during production of this report.

## 2.D COLORADO ALTERNATIVE

### 2.D.1 SLURRY PIPELINE SYSTEM

Wyoming

Streams and rivers which would be crossed by the Colorado Alternative through Wyoming are listed in Table 61. From north to south the Colorado Alternative would traverse the following Wyoming drainage basins:

- Belle Fourche Basin
- Cheyenne Basin
- North Platte Basin
- South Platte Basin

The aquatic biology of the Belle Fourche and Cheyenne basins were described in Sections 2.A.1, 2.A.2, and 2.A.3 of this report.

The North Platte River would be traversed by the Colorado Alternative corridor at MP 112 in Goshen County. Near the proposed crossing the stream bottom varies from sand to large rock (Missouri Basin Power Project 1975).

Table 61 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE COLORADO ALTERNATIVE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Little Thunder Creek | 3 | I | Campbell |
| Little Thunder Creek | 4 | I | Campbell |
| UT Little Thunder Creek | 6 | I | Campbell |
| UT Little Thunder Creek | 6.5 | I | Campbell |
| UT Piney Creek | 11 | I | Weston |
| UT Piney Creek | 12 | I | Weston |
| UT Piney Creek | 13 | I | Weston |
| UT Frog Creek | 14 | I | Weston |
| UT Frog Creek | 15 | I | Weston |
| UT Frog Creek | 15.5 | I | Weston |
| UT Frog Creek | 17 | I | Weston |
| Unnamed stream | 18 | I | Weston |
| UT Keyton Creek | 19 | I | Weston |
| Keyton Creek | 19.5 | I | Weston |
| Horse Creek | 21 | I | Converse |
| Cheyenne River | 23 | I | Converse |
| UT Sheep Creek | 27 | I | Converse |
| UT Sheep Creek | 29 | I | Converse |
| UT Wagon Hound Creek | 30.5 | I | Converse |
| UT Cow Creek | 31 | I | Converse |
| UT Cow Creek | 33 | I | Converse |
| Cow Creek | 34 | I | Converse |
| UT Cow Creek | 36 | I | Niobrara |
| UT Cow Creek | 36.5 | I | Niobrara |
| Little Cow Creek | 39.5 | I | Niobrara |
| UT Little Cow Creek | 41 | I | Niobrara |
| UT Lightning Creek | 43 | I | Niobrara |
| UT Lightning Creek | 43.5 | I | Niobrara |
| UT Lightning Creek | 44 | I | Niobrara |
| UT Lightning Creek | 45 | I | Niobrara |
| Lightning Creek | 46 | I | Niobrara |
| Twentymile Creek | 49.5 | I | Niobrara |
| UT Twentymile Creek | 50 | I | Niobrara |
| UT Twentymile Creek | 51 | I | Niobrara |
| UT Twentymile Creek | 55 | I | Niobrara |
| UT Little Lightning Creek | 56 | I | Niobrara |
| UT Little Lightning Creek | 57 | I | Niobrara |
| UT Little Lightning Creek | 58 | I | Niobrara |
| UT Little Lightning Creek | 58.5 | I | Niobrara |
| UT Little Lightning Creek | 59 | I | Niobrara |
| Little Lightning Creek | 59 | I | Niobrara |
| Lance Creek | 64 | I | Niobrara |

Table 61 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Lance Creek | 65 | I | Niobrara |
| UT Bliss Creek | 69 | I | Niobrara |
| UT Muddy Creek | 74 | I | Niobrara |
| UT Muddy Creek | 76 | I | Niobrara |
| UT Muddy Creek | 78 | I | Niobrara |
| UT Muddy Creek | 81 | I | Niobrara |
| Willow Creek | 84 | I | Niobrara |
| Unnamed stream | 86 | I | Goshen |
| Unnamed stream | 87 | I | Goshen |
| UT Broom Creek | 89 | I | Goshen |
| UT Broom Creek | 90.5 | I | Goshen |
| Unnamed stream | 95 | I | Goshen |
| Unnamed stream | 98 | I | Goshen |
| Unnamed stream | 99 | I | Goshen |
| Unnamed stream | 101 | I | Goshen |
| Unnamed stream | 103 | I | Goshen |
| Unnamed stream | 103.5 | I | Goshen |
| UT North Platte River | 105 | I | Goshen |
| UT North Platte River | 105.5 | I | Goshen |
| UT North Platte River | 106 | I | Goshen |
| UT North Platte River | 107 | I | Goshen |
| UT Molly Fork | 109 | I | Goshen |
| Interstate Canal | 110.5 | P | Goshen |
| North Platte River[2] | 112 | P | Goshen |
| Laramie River | 113 | P | Goshen |
| Fort Laramie Canal | 114 | P | Goshen |
| Deer Creek | 115 | I | Goshen |
| Cherry Creek | 124 | I | Goshen |
| Unnamed stream | 125 | I | Goshen |
| Unnamed stream | 128 | I | Goshen |
| Box Elder Creek | 137 | I | Goshen |
| Unnamed stream | 143 | I | Goshen |
| Fox Creek | 149 | P | Goshen |
| Bear Creek | 156.5 | P | Goshen |
| Spring Run | 157.5 | I | Goshen |
| Horse Creek | 164.5 | P | Laramie |
| UT Horse Creek | 165 | I | Laramie |
| Sprager Creek | 167.5 | I | Laramie |
| Sprager Creek | 168 | I | Laramie |
| Sprager Creek | 169.5 | I | Laramie |
| Unnamed stream | 174 | I | Laramie |
| Unnamed stream | 178 | I | Laramie |
| Lodgepole Creek | 183.5 | P | Laramie |
| Muddy Creek | 195 | I | Laramie |

Dominant macroinvertebrates in the North Platte River are mayflies, caddisflies and chironomids. Stoneflies are also present but less common. Fishes known to occur in the affected portion of the North Platte River are listed in Table 62.

The Colorado Alternative would cross the Laramie River at MP 113 in Goshen County, Wyoming. The Laramie River and many of its tributaries support riparian vegetation. The riparian vegetation is characterized by cottonwood, willow, Russian olive, and several species of sedges and rushes (Missouri Basin Power Project 1975).

The small tributaries to the Laramie River are characterized by stone and rubble bottoms, relatively good water quality and a plentiful supply of algae and organic detritus (Missouri Basin Power Project 1975). These conditions contribute to the diverse invertebrate fauna in the basin. Mayflies, caddisflies and dipterans are the predominant benthic macroinvertebrates in the Laramie River.

Fishes known to occur in the Laramie River are listed in Table 63. The only fishes present which could be classified as a game species are the green sunfish and brown trout.

The green sunfish is not sought by area anglers because of the fish's small size (Missouri Basin Power Project 1975). The portion of the Laramie River which would be traversed was rated as low productivity waters by the Wyoming Game and Fish Commission (1971) and is probably incapable of supporting other than local fishing pressure.

Colorado

A list of streams and rivers which would be traversed by the Colorado Alternative through Colorado are listed in Table 64. From north to south the route would traverse the South Platte and Republican Rivers basins.

Table 62 FISHES KNOWN TO OCCUR IN THE NORTH PLATTE RIVER NEAR THE PROPOSED COLORADO ALTERNATIVE CROSSING (MISSOURI BASIN POWER PROJECT 1975 AND WYOMING GAME AND FISH DEPARTMENT 1979)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY CLUPEIDAE | SHADS |
| *Dorosoma cepedianum* | Gizzard shad |
| FAMILY SALMONIDAE | TROUTS |
| *Salmo gairdneri* | Rainbow trout |
| *Salmo trutta* | Brown trout |
| FAMILY ESOCIDAE | PIKES |
| *Esox lucius* | Northern pike |
| FAMILY CYPRINIDAE | MINNOWS AND SHINERS |
| *Campostoma anomalum* | Stoneroller |
| *Cyprinus carpio* | Carp |
| *Hybognathus placitus* | Plains minnow |
| *Notropis lutrensis* | Red shiner |
| *Notropis stramineus* | Sand shiner |
| *Pimephales promelas* | Flathead minnow |
| *Rhinichthys cataractae* | Longnose dace |
| *Semotilus atromaculatus* | Creek chub |
| *Semotilus margarita* | Pearl dace |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Catostomus catostomus* | Longnose sucker |
| *Catostomus commersoni* | White sucker |
| *Moxostoma macrolepidotum* | Northern redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus flavus* | Stonecat |
| FAMILY PERCIDAE | PERCHES |
| *Etheostoma nigrum* | Johnny darter |
| *Stizostedion canadense* | Sauger |
| *Stizostedion vitreum vitreum* | Walleye |

Table 63 FISHES KNOWN TO OCCUR IN THE PORTION OF THE LARAMIE RIVER WHICH WOULD BE CROSSED BY THE COLORADO ALTERNATIVE IN WYOMING (MISSOURI BASIN POWER PROJECT 1975 AND WYOMING GAME AND FISH DEPARTMENT 1979)

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| FAMILY SALMONIDAE | TROUT |
| *Salmo trutta* | Brown trout |
| FAMILY CYPRINIDAE | MINNOWS AND SHINERS |
| *Campostoma anomalum* | Stoneroller |
| *Cyprinus carpio* | Carp |
| *Hybognathus placitus* | Plains minnow |
| *Notropis cornutus* | Common shiner |
| *Notropis lutrensis* | Red shiner |
| *Notropis stramineus* | Sand shiner |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Pimephales promelas* | Flathead minnow |
| *Rhinichthys cataractae* | Longnose dace |
| *Semotilus atromaculatus* | Creek chub |
| FAMILY CATOSTOMIDAI | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Catostomus catostomus* | Longnose sucker |
| *Catostomus commersoni* | White sucker |
| *Moxostoma macrolepidotom* | Shorthead redhorse |
| FAMILY ICTALURIDAE | CATFISHES |
| *Noturus flavus* | Stonecat |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |

Table 64 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE COLORADO ALTERNATIVE THROUGH COLORADO
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary; 2=404 permit required)

| Stream | MP | Flow | County |
|---|---|---|---|
| Unnamed stream | 221 | I | Weld |
| UT North Pawnee Creek | 223 | I | Weld |
| UT North Pawnee Creek | 225 | I | Weld |
| UT North Pawnee Creek | 229 | I | Weld |
| UT North Pawnee Creek | 231.5 | I | Weld |
| Cottonwood Creek | 238 | I | Weld |
| Pawnee Creek | 246 | I | Weld |
| UT Pawnee Creek | 247 | I | Weld |
| UT Pawnee Creek | 248.5 | I | Weld |
| UT Pawnee Creek | 249 | I | Weld |
| Rawhide Creek | 254 | I | Logan |
| UT Pawnee Creek | 257 | I | Logan |
| UT Pawnee Creek | 258.5 | I | Logan |
| Sand Creek | 259.5 | I | Logan |
| North Sterling Canal | 265 | P | Logan |
| Pawnee Ditch | 267 | P | Logan |
| South Platte River[2] | 268 | P | Logan |
| Davis Brothers Ditch | 269.5 | P | Logan |
| Unnamed stream | 278.5 | I | Washington |
| Unnamed stream | 280 | I | Washington |
| Unnamed stream | 282 | I | Washington |
| Unnamed stream | 283 | I | Washington |
| UT Rock Creek | 285 | I | Washington |
| UT Rock Creek | 287 | I | Washington |
| Rock Creek | 289 | I | Washington |
| Surveyor Creek | 302 | I | Yuma |
| Chief Creek | 328.5 | I | Yuma |
| North Fork Republican River | 331.5 | P | Yuma |
| UT Dry Willow Creek | 342 | I | Yuma |
| UT Dry Willow Creek | 346 | I | Yuma |
| UT Dry Willow Creek | 346.5 | I | Yuma |
| Arikaree River | 347 | P | Yuma |
| UT Arikaree River | 350 | I | Yuma |

The South Platte River would be crossed at MP 268. The South Platte is a gaining stream; in other words, the stream lies below the water table and gains water form it as it flows downstream. Reservoirs and water diversion structures have significantly altered discharge and channel characteristics of the South Platte River. In its unaltered state the South Platte River is a wide, shallow river braided with sand bars. Irrigation reservoirs and diversion dams have changed the South Platte to a narrow, deep and steeply banked river. Irrigation in the basin has increased siltation and consequently, mud covers what was once a sandy bottom.

The South Platte River is notorious for its polluted waters (Li 1968). According to the Fish and Wildlife Task Force (1967), most of the rivers major tributaries and 229 miles of the river proper are badly degraded.

Fish habitat has been reduced further by stream channelization. Meanders, pools and cover have been eliminated; a smooth, uniform bottom and a monotonous environment exists in their place. Stretches of the South Platte River which once contained native trout are now devoid of all fish. The proposed crossing of the South Platte provides, at best, a limited fishery resource (U.S. Fish and Wildlife Service and Colorado Division of Wildlife 1979).

Fishes collected by Li (1968) in the lower sections of the South Platte River are listed in Table 65.

The plains orangethroat darter (Etheostoma spectabile pulchellum) occurs in the North Fork Republican River (MP 331.5), the Arikaree River (MP 347) and Chief Creek (MP 328.5). This fish is considered threatened in Colorado. Because these streams contain a state protected species they were rated as Class I waters by the U.S. Fish and Wildlife Service and the Colorado Division of Wildlife (1979).

Table 65 FISHES COLLECTED FROM THE LOWER SECTIONS OF THE SOUTH PLATTE RIVER BY LI (1968)

| SCIENTIFIC NAME | COMMON NAME |
| --- | --- |
| | CYPRINIDAE |
| *Semotilus atromaculatus* | Creek chub |
| *Phenacobius mirabilis* | Suckermouth minnow |
| *Notropis lutrensis* | Red shiner |
| *Notropis dorsalis* | Bigmouth shiner |
| *Notropis stramineus* | Sand shiner |
| *Hybognathus hankinsoni* | Brassy minnow |
| *Pimephales promelas* | Fathead minnow |
| *Campostoma anomalum* | Stoneroller |
| | CATOSTOMIDAE |
| *Catostomus commersoni* | White sucker |
| | ICTALURIDAE |
| *Ictalurus punctatus* | Channel catfish |
| *Ictalurus melas* | Black bullhead |
| | CYPRINODONTIDAE |
| *Fundulus kansae* | Plains killifish |
| *Fundulus sciadicus* | Plains topminnow |
| | CENTRARCHIDAE |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis humilis* | Orangespotted sunfish |

Kansas

From east to west the Colorado Alternative corridor would traverse the following Kansas drainage basins:

- Upper Republican River Basin
- Solomon River Basin
- Saline River Basin
- Smoky Hill River Basin
- Lower Arkansas River Basin
- Little Arkansas River Basin

Streams and rivers which would be crossed by the Colorado Alternate Route through Kansas are listed in Table 66.

Upper Republican River Basin. Cherry Creek would be crossed by the Colorado Alternative route at MP 364.5 in Cheyenne County. The Topeka shiner (*Notropis topeka*) is known to occur in this drainage and is listed as threatened by the Kansas Fish and Game Commission.

The Colorado Alternative would traverse the South Fork Republican River at MP 365.5 in Cheyenne County, Kansas. The South Fork, near the proposed crossing, ranges between 20 and 24 feet in width and has an average depth of 12 inches (Kansas Forestry, Fish and Game Commission 1977a). The substrate in this portion of the South Fork consists of small gravel interspersed with sand. Riffles are present. The stream banks are mostly sand and gravel and are undercut.

Willows and cottonwoods make up the woody riparian vegetation. The understory consists mostly of sandsage, rabbit brush, fireweed, Russian thistle, sedges and mixed grasses. Bullrushes grow along the shoreline.

The streambed is dry from four to six months annually (Kansas Forestry, Fish and Game Commission 1977a). The most abundant macro-

Table 66 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE COLORADO ALTERNATIVE THROUGH KANSAS
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Cherry Creek | 359 | I | Cheyenne |
| UT Cherry Creek | 364 | I | Cheyenne |
| Cherry Creek | 364.5 | I | Cheyenne |
| UT So. Fork Republican River | 365 | I | Cheyenne |
| So. Fork Republican River | 365.5 | I | Cheyenne |
| UT So. Fork Republican River | 366 | I | Cheyenne |
| W. Fork Sand Creek | 369.5 | I | Cheyenne |
| UT W. Fork Sand Creek | 370.5 | I | Cheyenne |
| UT Sand Creek | 371 | I | Cheyenne |
| Sand Creek | 372 | I | Cheyenne |
| Little Beaver Creek | 384 | I | Cheyenne |
| Beaver Creek | 389 | P | Sherman |
| UT Beaver Creek | 389.5 | I | Sherman |
| UT Beaver Creek | 391 | I | Sherman |
| M. Fork Sappa Creek | 400 | I | Thomas |
| So. Fork Sappa Creek | 408 | I | Thomas |
| UT So. Fork Sappa Creek | 409 | I | Thomas |
| UT Prairie Dog Creek | 411 | I | Thomas |
| Prairie Dog Creek | 412 | I | Thomas |
| No. Fork Solomon River | 418 | I | Thomas |
| UT So. Fork Solomon River | 423 | I | Thomas |
| So. Fork Solomon River | 426 | I | Thomas |
| UT So. Fork Solomon River | 426.5 | I | Thomas |
| UT So. Fork Solomon River | 428 | I | Thomas |
| UT So. Fork Solomon River | 429.5 | I | Thomas |
| UT So. Fork Solomon River | 430.5 | I | Thomas |
| UT So. Fork Solomon River | 432 | I | Thomas |
| UT No. Fork Saline River | 433 | I | Thomas |
| UT No. Fork Saline River | 438 | I | Thomas |
| UT No. Fork Saline River | 439 | I | Thomas |
| UT Saline River | 440 | I | Thomas |
| UT Saline River | 441 | I | Sheridan |
| Saline River | 442 | I | Sheridan |
| UT Saline River | 443 | I | Sheridan |
| UT Saline River | 445 | I | Sheridan |
| UT Saline River | 446 | I | Sheridan |
| UT Saline River | 447 | I | Sheridan |
| UT Saline River | 448 | I | Sheridan |
| UT Saline River | 449.5 | I | Sheridan |
| UT Saline River | 451 | I | Sheridan |
| UT Big Creek | 454 | I | Gove |
| UT Big Creek | 456 | I | Gove |
| UT Big Creek | 458 | I | Gove |
| UT Big Creek | 460.5 | I | Gove |
| UT Big Creek | 463 | I | Gove |
| UT Big Creek | 464 | I | Gove |

Table 66 (continued)

(MP=Approximate pipeline milepost at proposed crossing;
I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Big Creek | 465 | I | Gove |
| UT Big Creek | 466 | I | Gove |
| UT Big Creek | 467 | I | Gove |
| Big Creek | 470 | I | Gove |
| Big Creek | 470.5 | I | Gove |
| Big Creek | 471 | I | Gove |
| Big Creek | 471.5 | I | Gove |
| Big Creek | 472 | I | Gove |
| UT Big Creek | 474.5 | I | Gove |
| UT Big Creek | 476 | I | Trego |
| Big Creek | 479.5 | I | Trego |
| E. Branch Downer Creek | 486 | I | Trego |
| UT Cedar Bluff Reservoir | 490.5 | I | Trego |
| UT Cedar Bluff Reservoir | 491 | I | Trego |
| UT Big Creek | 495 | I | Trego |
| UT Cedar Bluff Reservoir | 495.5 | I | Trego |
| UT Cedar Bluff Reservoir | 497 | I | Trego |
| UT Big Creek | 497.5 | I | Trego |
| UT Smokey Hill River | 499.5 | I | Trego |
| UT Smokey Hill River | 501.5 | I | Trego |
| UT Smokey Hill River | 503 | I | Trego |
| UT Smokey Hill River | 504 | I | Trego |
| UT Smokey Hill River | 506 | I | Trego |
| UT Smokey Hill River | 507 | I | Trego |
| UT Smokey Hill River | 511 | I | Ellis |
| UT Smokey Hill River | 513 | I | Ellis |
| UT Smokey Hill River | 513.5 | I | Ellis |
| UT Smokey Hill River | 514 | I | Ellis |
| UT Smokey Hill River | 514.5 | I | Ellis |
| UT Smokey Hill River | 516 | I | Ellis |
| UT Smokey Hill River | 517 | I | Ellis |
| UT Smokey Hill River | 518 | I | Ellis |
| UT Smokey Hill River | 518.5 | I | Ellis |
| UT Smokey Hill River | 519 | I | Ellis |
| UT Smokey Hill River | 520 | I | Ellis |
| UT Smokey Hill River | 521 | I | Ellis |
| UT Smokey Hill River | 523 | I | Ellis |
| UT Smokey Hill River | 525.5 | I | Ellis |
| UT Smokey Hill River | 526 | I | Ellis |
| UT Smokey Hill River | 529 | I | Ellis |
| Smokey Hill River | 533 | I | Ellis |
| UT Smokey Hill River | 536 | I | Rush |
| UT Smokey Hill River | 537 | I | Rush |
| Duck Creek | 537.5 | I | Rush |
| UT Duck Creek | 538 | I | Rush |

Table 66 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| Eagle Creek | 541 | I | Rush |
| UT Smokey Hill River | 543 | I | Barton |
| UT Landon Creek | 547 | I | Barton |
| Landon Creek | 549.5 | P | Barton |
| UT Sellens Creek | 552 | P | Barton |
| Sellens Creek | 552.5 | P | Barton |
| UT Sellens Creek | 554 | I | Barton |
| UT Sellens Creek | 555 | I | Barton |
| UT Deception Creek | 557 | I | Barton |
| UT Deception Creek | 557.5 | I | Barton |
| Deception Creek | 558 | P | Barton |
| UT Deception Creek | 561 | I | Barton |
| Unnamed stream | 563 | I | Barton |
| UT Cow Creek | 565 | I | Barton |
| Cow Creek | 566 | P | Barton |
| UT Cow Creek | 568 | P | Barton |
| UT Cow Creek | 571.5 | I | Barton |
| UT Cow Creek | 572 | I | Barton |
| UT Cow Creek | 573 | I | Barton |
| UT Calf Creek | 575 | I | Barton |
| UT Calf Creek | 575.5 | I | Ellsworth |
| UT Calf Creek | 577 | I | Ellsworth |
| Calf Creek | 578 | I | Ellsworth |
| UT Plum Creek | 579.5 | P | Ellsworth |
| UT Plum Creek | 580.5 | I | Ellsworth |
| Plum Creek | 582 | P | Rice |
| UT Lost Creek | 584 | I | Rice |
| UT Lost Creek | 585 | I | Rice |
| Lost Creek | 585.5 | P | Rice |
| UT Lost Creek | 586 | I | Rice |
| UT Lost Creek | 587 | I | Rice |
| UT Lost Creek | 587.5 | I | Rice |
| UT Lost Creek | 588 | I | Rice |
| Little Cow Creek | 589.5 | P | Rice |
| UT Little Cow Creek | 590 | I | Rice |
| UT Little Cow Creek | 591 | I | Rice |
| UT Little Cow Creek | 591.5 | I | Rice |
| UT Little Cow Creek | 593 | I | Rice |
| UT Little Arkansas River | 594 | I | Rice |
| UT Little Arkansas River | 595 | I | Rice |
| UT Little Arkansas River | 596 | I | Rice |
| Little Arkansas River | 597 | P | Rice |
| Little Arkansas River | 597.5 | P | Rice |
| Little Arkansas River | 598 | P | Rice |
| Horse Creek | 602 | I | Rice |

invertebrates in the South Fork are water boatmen and simuliids. Back-swimmers, chironomids, caddisflies and giant water bugs are common. Dipterans also occur.

Angling opportunity does not exist in this portion of the Republican River. During the dry periods, standing pools provide holding situations for the minnow populations. Orangethroat darters, stonerollers, sand and red shiners, bluntnose minnows, plains killifish and plains minnows constitute the South Forks ichthyofauna (Kansas Forestry, Fish and Game Commission 1977a).

The Colorado Alternative would cross Beaver Creek at MP 389 in Sherman County. Beaver Creek near the proposed crossing averages 15 feet in width and 2 feet in depth (Kansas Forestry, Fish and Game Commission 1977a). Beaver Creek meanders through a flat floodplain and the stream banks are mostly mud. The substrate is mostly sand covered with silt. Low growing forbs occupy most of the floodplain. Willow saplings occur throughout the area. Aquatic invertebrates consist of chironomids, snails, clams and blackfly larvae (Kansas Forestry, Fish and Game Commission 1977a). Game fish present in Beaver Creek include black bullheads, green sunfish, orangespotted sunfish, carp and channel catfish. Occasionally bullheads and channel catfish are angled. The remainder of the fish fauna consists of white suckers, red and sand shiners, fathead minnows and creek chubs.

The Colorado Alternative would cross the South Fork Sappa Creek at MP 408 in Thomas County. The South Fork averages 15 feet in width and 12 inches in depth (Kansas Forestry, Fish and Game Commission 1977a). Pool substrate is mud. Cottonwoods and boxelder are dominant. The sparse understory consists of a few short grasses and forbs. Apparently, aquatic vegetation is lacking. Limited angling opportunity exists in this stretch of the South Fork. The ichthyofauna consists of black bullheads, green sunfish and fathead minnows.

Solomon River Basin. The Colorado Alternative would cross the North Fork Solomon River at approximately MP 418 in Thomas County, Kansas. Near

the proposed crossing the North Fork is approximately 50 feet wide and 1 foot deep. The steam is interspersed with small sandbars. Both banks are steep and heavily wooded with tall cottonwood and hackberry. The upper banks are covered with foxtail and common ragweed. Very little understory exists due to the dense shading (Kansas Forestry, Fish and Game Commission 1977b). The substrate consists mostly of sandy gravel.

Mayflies and crayfish (Orconectes) are present. Mussels in the North Fork Solomon River include the maple-leaf mussel (Quadrula quadrula), pimple-backed mussel (Quadrula pustulosa) and fragile paper mussel (Leptodea fragilis).

Angling success in portions of the North Fork Solomon River is good for channel and flathead catfish and carp. Occasionally during a wet spring, a small white bass spawning run occurs. Green sunfish, crappie, river carpsucker, drum, suckermouth minnows, red and sand shiners, fathead minnows and stonecats are also present (Kansas Forestry, Fish and Game Commission 1977b).

Saline River Basin. The Colorado Alternative would cross the Saline River at MP 442 in Sheridan County, Kansas. This portion of the Saline River is usually dry in the summer. Croplands run to the streambanks and during the dry months the streambed is colonized by cottonwood and willow (Kansas Fish and Game Commission 1979a).

When water is present the macroinvertebrate fauna probably consists of water boatmen, dragonflies, damselflies and mayfly numphs. The ichthyofauna would probably consist mostly of minnows and shiners.

Smoky Hill River Basin. The Colorado Alternative would cross the Smoky Hill River at approximately MP 533 in Ellis County, Kansas. Near the proposed crossing the stream averages 50 feet in width and 9 inches in depth (Kansas Fish and Game Commission 1979b).

The streambed consists mostly of sand. The banks are gently sloping. Little stream shading is provided by the few cottonwoods and numerous sandbar willows. Cattails grow along the stream margin in isolated patches.

Caddisfly larvae are abundant. Mayflies, stoneflies and simuliid larvae are common on rocks in the riffle areas. Chironomids and dragonfly larvae are also present.

Sportfish present in this section of the Smoky Hill River include white bass, channel catfish, and sunfish (Kansas Fish and Game Commission 1979b). The remainder of the fish fauna consists of river carpsucker, gizzard shad, suckermouth minnows, red and sand shiners, plains minnows, stonerollers, stonecats and orangethroat darters. Some angling for catfish probably occurs in the area.

Lower Arkansas River Basin. Cow Creek would be crossed by the Colorado Alternative at approximately MP 566 in Barton County. The stream averages 13 feet in width and 4 inches in depth (Kansas Fish and Game Commission 1978).

Catfish, sunfish and black bullheads comprise the game fish portion of Cow Creek's fish fauna. Carp, river carpsucker, red shiners, sand shiners and fathead minnows are also present.

Little Arkansas River Basin. The Colorado Alternative would cross the Little Arkansas River three times (MP 597, 597.5 and 598). At the proposed crossing the Little Arkansas River probably averages 17 feet in width and 3 feet in depth (Kansas Forestry, Fish and Game Commission 1977d). The streambed is primarily silt and sand. The overstory consists of cottonwood, elm, ash, maple and willow. The understory is mostly giant ragweed, goldenrod, smooth brome, foxtail, lambquarter, ironweed, poison ivy and cocklebur.

There is some channel catfish, flathead catfish and bullhead fishing in the Rice County portion of the Little Arkansas River. River carpsucker, sunfish, red shiners and fathead minnows are also present.

### 2.D.2 ANCILLARY FACILITIES

Ancillary facilities including transmission towers and power lines would be anticipated to be within the drainages described for the Colorado Alternative slurry pipeline system in Section 2.D.1, above. Site specific locations of these components were not available during production of this document.

## 2.E COAL CLEANING OPERATION ALTERNATIVE

The coal cleaning operation alternative involves the construction, operation, maintenance, and abandonment of coal cleaning facilities at each of the coal slurry preparation plants. The aquatic biological characteristics of the drainages potentially affected by the coal cleaning operation alternative were described in Section 2.A.1, above.

## 2.F CROOK COUNTY ALTERNATIVE

### 2.F.1 WATER WELLS

The Crook County Alternative well field would lie within the intermittent headwaters of the Little Missouri River system which drains the plains northwest of the Black Hills. The Wyoming Game and Fish Commission (1971) considers the streams of the area to be low-production waters. Studies by Wesche and Johnson (1980) in the neighboring Little Powder River basin, and Baxter and Simon (1970) suggest that fishes which might be expected in these streams (during spring flowing water period) include bullhead, bluegill, sunfish, bass, minnows, shiners, and dace.

Macroinvertebrates which would be expected in the area include flies (Diptera), caddisflies, mayflies, stoneflies, and some mollusk species. A more thorough discussion of invertebrates in the neighboring Thunder Creek Basin was presented in Section 2.A.1, above. It is anticipated that invertebrates in the Crook County well field would be similar to those in Thunder Creek Basin streams.

Streams potentially affected by Crook County Alternative drawdown of the Madison Formation include the Little Missouri River, Belle Fourche River, Sand Creek, Crow Creek Springs, Spearfish Creek and Stockade-Beaver Creek. The Belle Fourche River was previously described in Section 2.A.3. Sand and Spearfish Creeks are described in Section 2.G. Crow Creek Springs are discussed in Section 2.A.2.

Stockade-Beaver Creek was rated as Class II waters (high-priority fishery resource) by the Fish and Wildlife Service and South Dakota Department of Game, Fish and Parks (1978). The majority of Stockade-Beaver Creek lies in Wyoming. The South Dakota portion is managed for brook trout. The fishery potential of Stockade-Beaver Creek is limited by low stream flow (Stewart and Thilenius 1964).

### 2.F.2 GATHERING PIPELINES

Gathering pipelines would be contained within the well field. The aquatic biological characteristics of the well field drainage were described in Sections 2.F.1 and 2.A.1, above.

### 2.F.3 PUMP STATION

The Crook County Alternative pump station would be located in the well field. The aquatic biological characteristics of the well field drainage were described in Sections 2.F.1 and 2.A.1, above.

2.F.4 DELIVERY PIPELINE

Cottonwood Creek would be the only perennial stream crossed by the delivery pipeline at MP 29 in Campbell County (Table 67). It would be anticipated that the fishes and macroinvertebrates of Cottonwood Creek, and the intermittent streams which would be crossed, would be similar to those identified by Wesche and Johnson (1980) as indigenous to the Little Powder River. The Wyoming Game and Fish Commission (1971) considers all of these streams to be low-production waters.

2.F.5 ACCESS ROADS

The precise locations and extent of access road development are not known. Assuming, however, that access roads would be located within the drainages discussed under various other headings for this alternative (Sections 2.F.1 and 2.F.4) the biological resources would be anticipated to be similar

2.F.6 TRANSMISSION LINE NETWORK

The transmission line network is anticipated to be located within the drainages listed in Section 2.F.4, above. The biological characteristics of these drainages were described in Sections 2.F.4, 2.A.1, and 2.A.3, above.

2.G OAHE ALTERNATIVE

2.G.1 PIPELINE

The Oahe Reservoir Alternate Water Supply System would require that an intake be constructed in Oahe Reservoir, South Dakota. Benson (1968) reported that Oahe Reservoir has an average annual ice cover of 103 days; the reservoir usually freezes over about December 15th and opens around April 6th. The dam impounding the Missouri River and consequently creating Oahe Reservoir was closed in August of 1958. At conservation

Table 67 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE CROOK COUNTY ALTERNATIVE, WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Little Missouri River | 5 | I | Crook |
| UT Mud Creek | 6 | I | Crook |
| Mud Creek | 7 | I | Crook |
| UT Little Missouri River | 8 | I | Crook |
| UT Little Missouri River | 10.5 | I | Crook |
| UT Prairie Creek | 13 | I | Crook |
| Prairie Creek | 15 | I | Crook |
| UT Prairie Creek | 18.5 | I | Crook |
| Prairie Creek | 19 | I | Campbell |
| Spring Creek | 25 | I | Campbell |
| UT Spring Creek | 25.5 | I | Campbell |
| UT Spring Creek | 26 | I | Campbell |
| Cottonwood Creek | 29 | P | Campbell |
| UT Cottonwood Creek | 32 | I | Campbell |
| UT Cottonwood Creek | 35 | I | Campbell |
| UT Cow Creek | 38 | I | Campbell |
| UT Cow Creek | 39 | I | Campbell |
| Corral Creek | 41 | I | Campbell |
| Little Powder River | 44 | I | Campbell |
| Dry Fork Little Powder River | 46 | I | Campbell |

level, the average depth of Oahe Reservoir is about 60 feet with the maximum depth reaching 205 feet (Benson 1968). Most of the reservoirs substrate is a mixture of fine sediments and sand. Some portions of Oahe Reservoir have outcrops of loosely consolidated limestone.

The benthic fauna of Missouri River mainstem reservoirs has been studied by Needham (1961) and Schmulback and Sandholm (1962). Benson (1968) predicted a relatively low standing crop of benthic invertebrates in Oahe Reservoir. Hexagenia and chironomids are abundant in the Missouri mainstem reservoirs.

The most common fish species present in Oahe Reservoir appear in Table 68. Oahe Reservoir provides excellent angling for northern pike (Hassler 1970), walleye and yellow perch.

The common fishes of Oahe Reservoir spawn in relatively few habitats (Nelson and Beckman 1979). The reproductive characteristics of the more common Oahe fishes appear in Table 68 while their spawning habitats are listed on Table 69. Eight species spawn in the upper reaches of the reservoir's embayments. All of these embayment spawners have adhesive eggs which are typically deposited on vegetation in shallow waters. River spawners have more diverse reproductive habitats and move into the Cheyenne, Moreau, Grand and Cannonball rivers and their tributaries to spawn. Their eggs and larvae are transported downstream into the upper reaches of the river embayments. Consequently, the upper river embayments have the greatest diversity and abundance of larval fishes, since both embayment and tributary spawned larvae develop there (Beckman and Elrod 1971). The final important spawning habitat is the reservoir's exposed wave-washed shorelines. Wave action removes the finer soil particles revealing a more suitable hard sand, gravel or rubble substrate. Most spawning along the Oahe Reservoir shorelines occurs in water less than 2m deep (Nelson and Beckman 1979).

Table 68 REPRODUCTIVE CHARACTERISTICS OF THE MOST COMMON FISHES OF LAKE OAHE, SOUTH DAKOTA (NELSON AND BECKMAN 1979).

| Common Name | Scientific name | Egg | Location | Substrate | Reference |
|---|---|---|---|---|---|
| Goldeye | Hiodon alosoides | Semi-buoyant | Tributary streams, main stem | | Donald and Kooyman 1977 |
| Rainbow smelt | Osmerus mordax | Adhesive | Exposed reservoir shorelines | Gravel, rubble | Rupp 1965 |
| Northern pike | Esox lucius | Adhesive | Reservoir embayments | Vegetation | Scott and Crossman 1973 |
| Carp | Cyprinus carpio | Adhesive | Reservoir embayments | Vegetation | Scott and Crossman 1973 |
| Emerald shiner | Notropis atherinoides | Semi-buoyant | Exposed reservoir shorelines | Sand | Flittner 1964 |
| Spottail shiner | N. hudsonius | Unknown | Exposed reservoir shorelines | Sand | Mansueti and Hardy 1967 |
| Fathead minnow | Pimephales promelas | Adhesive | Reservoir embayments | Rocks, logs, branches | Scott and Crossman 1973 |
| Bigmouth buffalo | Ictiobus cyprinellus | Adhesive | Reservoir embayments | Vegetation | Johnson 1963 |
| River carpsucker | Carpiodes carpio | Unknown | Tributary streams, main stem | Vegetation | Brown 1971 |
| White sucker | Catastomus commersoni | Adhesive | Tributary streams, main stem | Gravel, rubble | Scott and Crossman 1973 |
| White bass | Morone chrysops | Adhesive | Tributary streams, main stem | Vegetation, sand, gravel | Riggs 1955 |
| White crappie | Pomoxis annularis | Adhesive | Reservoir embayments | Vegetation | Siefert 1968 |
| Black crappie | P. nigromaculatus | Adhesive | Reservoir embayments | Gravel, sand | Scott and Crossman 1973 |
| Yellow perch | Perca flavescens | Adhesive | Reservoir embayments | Vegetation | Thorpe 1977 |
| Sauger | Stizostedion canadense | Adhesive | Tributary streams, main stem | Gravel, rubble | Nelson 1968 |
| Walleye | S. vitreum vitreum | Adhesive | Tributary streams, main stem | Gravel, rubble | Scott and Crossman 1973 |
| Iowa darter | Etheostoma exile | Adhesive | Reservoir embayments | Vegetation | Scott and Crossman 1973 |

TABLE 69 SPAWNING HABITATS OF COMMON OAHE RESERVOIR FISHES.

| | | |
|---|---|---|
| EMBAYMENT SPAWNERS | | |
| | Northern pike | Esox lucius |
| | Carp | Cyprinus carpio |
| | Fathead minnow | Pimephales promelas |
| | Bigmouth buffalo | Ictiobus cyprinellus |
| | White crappie | Pomoxis annularis |
| | Black crappie | Pomoxis nigromaculatus |
| | Yellow perch | Perca flavescens |
| | Iowa darter | Etheostoma exile |
| RIVER SPAWNERS | | |
| | Goldeye | Hiodon alosoides |
| | River carpsucker | Carpiodes carpio |
| | White sucker | Catostomus commersoni |
| | White bass | Morone chrysops |
| | Sauger | Stizostedion canadense |
| | Walleye | Stizostedion vitreum vitreum |
| WAVE WASHED SHORELINE SPAWNERS | | |
| | Rainbow smelt | Osmerus mordax |
| | Emerald shiner | Notropis atherinoides |
| | Spottail shiner | Notropis hudsonius |
| | *Lake trout | Salvelinus namaycush |
| | *Lake whitefish | Coregonus clupeaformis |

* Lake whitefish and lake trout would probably spawn in this habitat if natural reproduction occurs in the reservoir.

Lake whitefish fry were introduced to Oahe in 1978 and are expected to reach sexual maturity in late 1981. Lake trout and lake whitefish are fall spawners and would probably utilize the wave-washed shorelines for spawning if natural reproduction occurs.

Larval fish first appear in Oahe Reservoir in early May, reach a maximum abundance in mid-June, and decline to relatively low densities through August (Nelson and Beckman 1979). Temporal distribution and periods of peak abundance for larvae collected from Oahe Reservoir by Nelson and Beckman (1979) are listed in Table 70 As illustrated in Figure 1 there are no critial spawning or nursery areas near the Oahe Dam proposed intake site.

Since 1972, permits have been required for installation and operation of intake systems in Oahe Reservoir. The criteria established to evaluate permit applications propose that intakes be at least 6 m deep, screened with at least 6 mm mesh or less and have an approach velocity not exceeding 0.5 feet per second. All irrigation systems presently permitted by the Corps of Engineers on Oahe Reservoir withdraw water for irrigation.

## South Dakota

Streams and rivers which would be crossed by the Oahe Alternative water supply pipeline through South Dakota are listed in Table 70. The proposed alternative water supply pipeline would cross portions of the Bad, Cheyenne, and Belle Fourche drainage basins between Oahe Reservoir (MP 0) and the South Dakota-Wyoming state line (MP 194). Fishes which could occur in streams and rivers which would be crossed appear in Table 72. Distribution data presented by Bailey and Allum (1962) and Scalet (1980) was used to compile the fish species list in Table 72.

Table 70 TEMPORAL DISTRIBUTION AND PEAK ABUNDANCE OF LARVAL FISH COLLECTED BY NELSON AND BECKMAN (1979) AT THE SWAN CREEK EMBAYMENT, OAHE RESERVOIR, SOUTH DAKOTA

| Species/Group | Period of Occurrence | Peak Abundance |
|---|---|---|
| White bass (*Morone chrysops*) | 10 June-15 August | 20-30 June |
| Carp (*Cyprinus carpio*) | 15 May-15 August | 30 May |
| Buffalo (*Ictiobus* spp.) | 20 May-15 August | 30 June |
| White sucker (*Catostomus commersoni*) | 1 May-10 July | 20 May |
| Yellow perch (*Perca flavescens*) | 1 May-30 August | 30 May-20 June |
| Shiners (Cyprinidae) | 10 June-15 August | 10 July |

FIGURE 1
CRITICAL FISH SPAWNING AREAS IN THE LOWER SEGMENT OF OAHE RESERVOIR, SOUTH DAKOTA (NELSON AND BECKMAN 1979)

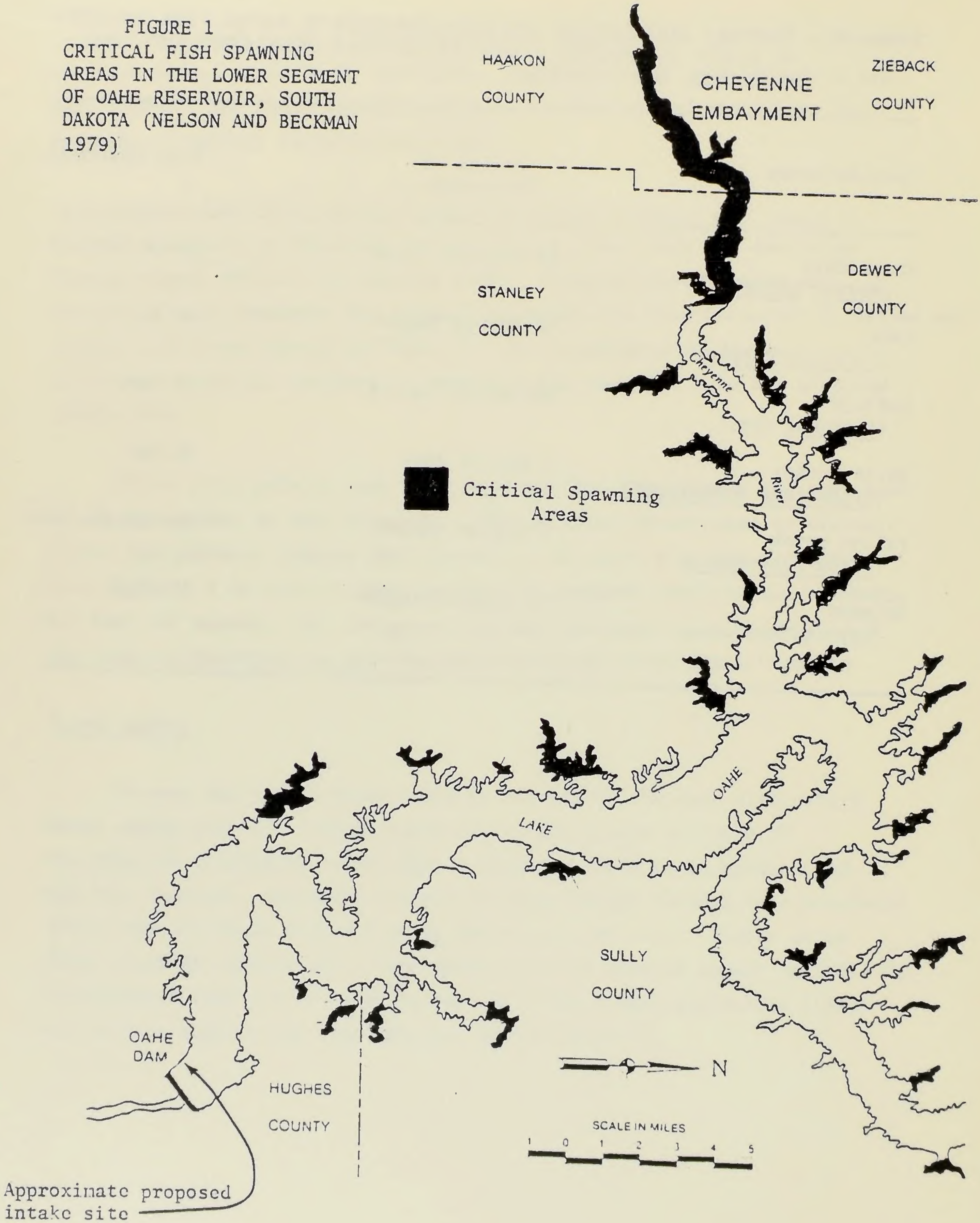

Table 71 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE OAHE ALTERNATIVE THROUGH SOUTH DAKOTA
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| * | | | |
| Willow Creek | 9 | I | Stanley |
| UT Willow Creek | 11 | I | Stanley |
| UT Willow Creek | 12 | I | Stanley |
| UT Willow Creek | 13 | I | Stanley |
| UT Lance Creek | 18 | I | Stanley |
| UT Lance Creek | 18.5 | I | Stanley |
| UT Lance Creek | 20 | I | Stanley |
| UT Lance Creek | 22 | I | Stanley |
| UT Lance Creek | 24 | I | Stanley |
| UT Plum Creek | 26 | I | Stanley |
| UT Plum Creek | 28 | I | Stanley |
| UT Plum Creek | 29 | I | Stanley |
| UT Plum Creek | 31 | I | Stanley |
| UT Plum Creek | 32 | I | Stanley |
| UT Plum Creek | 32.5 | I | Stanley |
| UT Plum Creek | 36 | I | Stanley |
| UT Plum Creek | 36.5 | I | Stanley |
| UT Plum Creek | 38 | I | Stanley |
| UT Plum Creek | 38.5 | I | Stanley |
| Cottonwood Creek | 41 | I | Haakon |
| UT Plum Creek | 47 | I | Haakon |
| UT Plum Creek | 48 | I | Haakon |
| UT Plum Creek | 51 | I | Haakon |
| UT Mule Creek | 52 | I | Haakon |
| UT Mule Creek | 53 | I | Haakon |
| UT West Plum Creek | 58 | I | Haakon |
| UT West Plum Creek | 59 | I | Haakon |
| UT West Plum Creek | 60.5 | I | Haakon |
| UT West Plum Creek | 61 | I | Haakon |
| UT West Plum Creek | 61.5 | I | Haakon |
| UT West Plum Creek | 62 | I | Haakon |
| UT Snake Creek | 66 | I | Haakon |
| UT Snake Creek | 68 | I | Haakon |
| UT Snake Creek | 69 | I | Haakon |
| UT Snake Creek | 70.5 | I | Haakon |
| UT Snake Creek | 71 | I | Haakon |
| UT Snake Creek | 71.5 | I | Haakon |
| UT Bridger Creek | 75 | I | Haakon |
| UT Bridger Creek | 77 | I | Haakon |
| UT Ash Creek | 79 | I | Haakon |
| UT Ash Creek | 80.5 | I | Haakon |

* A section 10 permit would be required for the Oahe Reservoir.

Table 71 (continued)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Ash Creek | 81.5 | I | Haakon |
| UT Deep Creek | 84 | I | Pennington |
| UT Deep Creek | 85 | I | Pennington |
| UT Deep Creek | 87 | I | Pennington |
| UT Deep Creek | 88 | I | Pennington |
| UT Deep Creek | 89 | I | Pennington |
| UT Deep Creek | 91 | I | Pennington |
| UT Cheyenne River | 93 | I | Pennington |
| UT Cheyenne River | 96 | I | Pennington |
| UT Cheyenne River | 98 | I | Pennington |
| UT Cheyenne River | 98.5 | I | Pennington |
| UT Cheyenne River | 102 | I | Pennington |
| UT Cheyenne River | 102.5 | I | Pennington |
| Cheyenne River | 103 | P | Pennington |
| UT Elk Creek | 107 | I | Pennington |
| UT Elk Creek | 111 | I | Pennington |
| UT Elk Creek | 111.5 | I | Pennington |
| UT Elk Creek | 113 | I | Pennington |
| UT Elk Creek | 117 | I | Pennington |
| Elk Creek | 119 | I | Meade |
| UT Elk Creek | 119.5 | I | Meade |
| UT Elk Creek | 120 | I | Meade |
| UT Elk Creek | 121 | I | Meade |
| UT Elk Creek | 125 | I | Meade |
| UT Elk Creek | 126 | I | Meade |
| UT Elk Creek | 129 | I | Meade |
| UT Elk Creek | 130.5 | I | Meade |
| UT Elk Creek | 132 | I | Meade |
| UT Elk Creek | 134 | I | Meade |
| UT Elk Creek | 135 | I | Meade |
| UT Elk Creek | 135.5 | I | Meade |
| UT Elk Creek | 136 | I | Meade |
| UT Elk Creek | 137 | I | Meade |
| UT Elk Creek | 137.5 | I | Meade |
| UT Elk Creek | 138 | I | Meade |
| UT Elk Creek | 139 | I | Meade |
| UT Elk Creek | 139.5 | I | Meade |
| UT Antelope Creek | 141 | I | Meade |
| UT Antelope Creek | 144 | I | Meade |
| Antelope Creek | 145 | I | Meade |
| UT Antelope Creek | 147 | I | Meade |

Table 71 (concluded)

(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| UT Antelope Creek | 147.5 | I | Meade |
| UT Antelope Creek | 148.5 | I | Meade |
| UT Alkali Creek | 152 | I | Meade |
| UT Alkali Creek | 153 | I | Meade |
| UT Alkali Creek | 155 | I | Meade |
| UT Alkali Creek | 155.5 | I | Meade |
| UT Alkali Creek | 157 | I | Meade |
| UT Alkali Creek | 158 | I | Meade |
| UT Alkali Creek | 159 | I | Meade |
| UT Bear Butte Creek | 161 | I | Meade |
| Bear Butte Creek | 162 | P | Meade |
| UT Bear Butte Creek | 162.5 | I | Meade |
| UT Bear Butte Creek | 163 | I | Meade |
| UT Spring Creek | 165 | I | Meade |
| Spring Creek | 165.5 | I | Meade |
| UT Spring Creek | 171 | I | Lawrence |
| Whitewood Creek | 173 | P | Lawrence |
| UT Whitewood Creek | 175 | I | Lawrence |
| UT Redwater River | 178 | I | Lawrence |
| UT Redwater River | 179 | I | Lawrence |
| UT Redwater River | 179.5 | I | Lawrence |
| UT Redwater River | 180.5 | I | Lawrence |
| UT Redwater River | 184 | I | Lawrence |
| UT Redwater River | 185 | I | Lawrence |
| UT Redwater River | 185.5 | I | Lawrence |
| Spearfish Creek | 188 | P | Lawrence |
| Crow Creek | 188.5 | I | Lawrence |
| UT Chicken Creek | 190 | I | Lawrence |
| UT Chicken Creek | 191 | I | Lawrence |
| Chicken Creek | 192 | I | Lawrence |
| UT Redwater Creek | 193.5 | I | Lawrence |

Table 72 FISHES WHICH COULD OCCUR IN STREAMS AND RIVERS WHICH WOULD BE TRAVERSED BY THE OAHE ALTERNATIVE WATER SUPPLY PIPELINE THROUGH SOUTH DAKOTA (DATA FROM BAILEY AND ALLUM 1962 AND SCALET 1980)

| | |
|---|---|
| FAMILY SALMONIDAE | TROUTS |
| *Salmo trutta* | Brown trout |
| *Salmo gairdneri* | Rainbow trout |
| *Salvelinus fontinalis* | Brook trout |
| FAMILY CYPRINIDAE | MINNOWS AND CARPS |
| *Cyprinus carpio* | Carp |
| *Semotilus atromaculatus* | Creek chub |
| *Phoxinus eos* | Northern redbelly dace |
| *Phoxinus neogaeus* | Finescale dace |
| *Hybopsis gracilis* | Flathead chub |
| *Hybopsis gelidia* | Sturgeon chub |
| *Rhinichthys cataractae* | Longnose dace |
| *Notropis stramineus* | Sand shiner |
| *Hybognathus placitus* | Plains minnow |
| *Pimephales promelas* | Fathead minnow |
| FAMILY CATOSTOMIDAE | SUCKERS |
| *Carpiodes carpio* | River carpsucker |
| *Moxostoma macrolepidotum* | Shorthead redhorse |
| *Catostomus commersoni* | White sucker |
| *Catostomus catostomus* | Longnose sucker |
| *Catostomus platyrhynchus* | Mountain sucker |
| FAMILY ICTALURIDAE | CATFISHES |
| *Ictalurus melas* | Black bullhead |
| *Ictalurus punctatus* | Channel catfish |
| *Noturus flavus* | Stonecat |
| FAMILY CYPRINODONTIDAE | KILLIFISHES |
| *Fundulus kansae* | Plains killifish |
| FAMILY CENTRARCHIDAE | SUNFISHES |
| *Lepomis cyanellus* | Green sunfish |
| *Lepomis humilis* | Orangespotted sunfish |
| FAMILY PERCIDAE | PERCHES |
| *Stizostedion vitreum* | Walleye |
| *Perca flavescens* | Yellow perch |

Missouri River reservoirs make up 72 percent of the surface water and support approximately 15 percent of the South Dakota's game fish population (South Dakota Department of Wildlife, Parks and Forestry 1978a). Tailwater fisheries of these reservoirs are extremely valuable fishery resources. The most heavily utilized angling waters in South Dakota are natural lakes (South Dakota Department of Wildlife, Parks and Forestry 1978b). Many of the state's natural lakes are affected by fluctuating groundwater levels and some shallower lakes annually lose their fish populations due to winter kill (South Dakota Geological Survey 1971a and 1971b). Artificial lakes, built in the 1930's are scattered throughout South Dakota. However, most have deteriorated and only about 25 percent still provide angling.

The value of seven streams which would be traversed by the proposed alternative, water supply line have been rated by the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks (1978) and are listed in Table 73.

The Cheyenne River, which would be crossed by the proposed Oahe Alternative water supply line at approximately MP 103, was rated as Class III waters by the U. S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks (1978). According to their classification scheme, the Cheyenne River in this area provides a substantial fishery resource. Water in this portion of the Cheyenne River is usually turbid and aquatic vegetation lacking (Bailey and Allum 1962). The stream width varies between 60 and 300 ft. with depths to 3 feet. The streambed is gravel and rubble on the riffles. Silt overlying sand occurs elsewhere.

According to Bailey and Allum (1962), the only sport fishes occuring in this section of the Cheyenne River are black bullheads, channel catfish and green sunfish. The nonsport component of the Cheyenne River fish fauna includes flathead chubs, longnose dace, sand shiners, plains minnows, river carpsucker, shorthead redhorses, white suckers, stonecats, plains killifish and orangespotted sunfish. Bailey and Allum (1962) also

Table 73 U.S. FISH AND WILDLIFE SERVICE AND THE SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS (1978) CLASSIFICATION OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE OAHE ALTERNATIVE WATER SUPPLY LINE THROUGH SOUTH DAKOTA

| Stream | MP at Crossing | Rating |
|---|---|---|
| Cheyenne River | 103 | Substantial Fishery Resource |
| Elk Creek | 119 | Substantial Fishery Resource |
| Bear Butte Creek | 162 | Limited Fishery Resource |
| Spring Creek | 165.5 | Limited Fishery Resource |
| Whitewood Creek | 173 | Limited Fishery Resource |
| Spearfish Creek | 188 | High-Priority Fishery Resource |
| Chicken Creek | 192 | High-Priority Fishery Resource |

collected sturgeon chubs (*Hybopsis gelida*) from the section of the Cheyenne River which would be crossed by the Oahe Alternative water supply line. The sturgeon chub is protected and listed as threatened by the South Dakota Department of Game, Fish and Parks.

The Cheyenne River is heavily silted and has no potential as a trout fishery (Stewart and Thilenius 1964). The Cheyenne River basin eventually drains the entire Black Hills, including the Belle Fourche drainage system.

Twenty-two intermittent tributaries to Elk Creek would be crossed by the Oahe Alternative water supply line between MP 107 and 139.5 in Pennington and Meade counties, South Dakota. The mainstem of Elk Creek would be crossed at MP 119. Elk Creek and its tributaries are characterized by low stream flow (Stewart and Thilenius 1964). A large section of the lower portion of the Elk Creek drainage is in an old burn area. The streams reduced flow is probably attributed to the recent closure of the forest canopy and livestock damage to springs in the upper reaches. Apparently, additional water losses result from well withdrawal in the lower drainage (Stewart and Thilenius 1964). Near the confluence of Meadow Creek, stream flow is reduced or completely lost by water uptake by the underlying limestone formation. The stream emerges several miles to the east.

Portions of the headwaters of Elk Creek in the Black Hills were classified as 2-a by Stewart and Thilenius (1964). The 2-a classification indicates that these sections are of fair quality and are managed for planted trout. Stewart and Thilenius considered the section of Elk Creek which would be traversed by the alternative water supply line as poor quality and unfit for trout (2-b). Some fishing for channel catfish may occur in sections of Elk Creek east of Highway 79 (South Dakota Department of Game, Fish and Parks 1972).

Intermittent tributaries and the mainstem of Bear Butte Creek would be crossed by the Oahe Alternative water supply line between MP 161 and 163. Recent closure of the forest canopy and water uptake in limestone formations probably cause the reduced stream flows in Bear Butte Creek (Stewart and Thilenius 1964). The portion of Bear Butte Creek which would be traversed by the alternative water supply line provides a limited fishery (U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks 1978 and Stewart and Thilenius 1964). About 2 miles of the creek's headwater area, west of Highway 79, are stocked with a few trout, but the fishery is only of local value. The proposed crossing occurs east of Highway 79. Strawberry Creek adds mine contaminated waters to Bear Butte Creek west of the proposed crossings.

Whitewood Creek would be crossed by the alternative water supply line at MP 173 and is the most severely polluted stream in the Black Hills region. The stream's poor water quality affects aquatic life in the Belle Fourche River for several miles below their confluence (Stewart and Thilenius 1964). Whitewood Creek carries an extremely heavy load of rock flour and chemical pollutants from mining operations and also transports domestic wastes from Lead and Deadwood creeks which intensifies pollution of the stream. Stewart and Thilenius (1964) classified Whitewood Creek as unfit for all recreational, domestic, agricultural and most industrial uses (3-b).

The Redwater River drainage basin would be crossed by the Oahe Alternative water supply line between MP 178 and 185.5. The Redwater River lies outside the northern edge of the Black Hills and is a high quality trout stream (Stewart and Thilenius 1964). It originates in Wyoming and flows through several limestone formations. Although fed by cold springs, summer temperatures are marginal and in drought years may become lethal. Density and quality of riparian vegetation is average but is being degraded by continued livestock grazing and plowing near the river. Road construction, especially in Wyoming, and plowing are both potential silt sources. Livestock in the area contribute to the organic matter in the stream. Natural trout reproduction occurs only occasionally (Stewart and Thilenius 1964). Classification of the river

between U.S. Highway 85 and the Belle Fourche River changes from high to poor quality due to higher water temperatures.

Two irrigation canals parallel portions of the Redwater River. The lower one, the Redwater Canal, is classified 2-b (poor quality) since it is too warm to be managed with trout. The upper canal, known as Thompson Ditch, is suited for trout although temperatures usually are marginal from July through mid-September. Both canals contain only flat water and do not have reproductive habitat for most species of game fish.

Primary tributaries of the upper southern parts of the Redwater River in South Dakota are all characterized by reduced stream flow. Crow Creek (MP 188.5) contains high quality water and has better than average production of food organisms. It supports a moderate population of trout (mostly planted). Livestock grazing has reduced the amount of riparian vegetation present along Crow Creek.

Sand Creek (MP 199) is located mainly in Wyoming. Stream flow in Sand Creek is reduced by water uptake in the limestone as well as closure of the forest canopy. Riparian vegetation is generally reduced along Sand Creek.

Two officially protected South Dakota fishes, the finescale dace (Phoxinus neogaeus) and longnose sucker (Catostomus catostomus), occur in streams which would be crossed by the Oahe Alternative water supply line in the Redwater River drainage. Rainbow trout, brown trout, white suckers, mountain suckers, longnose dace, green sunfish, shorthead redhorse, creek chubs, stonecats, flathead minnows, and black bullheads are also present in the Redwater River drainage system (Stewart and Thilenius 1964).

Spearfish Creek would be crossed by the proposed Oahe Alternative water supply line at MP 188 in Lawrence County, north of Spearfish, South Dakota. Spearfish Creek is the best trout stream in the Black Hills and was classified 1-a (highest quality) by Stewart and Thilenius (1964).

Spearfish Creek and most of its tributaries originate in limestone formations and flow through it for much of their length. The water is cold and rich in dissolved nutrients. Calcium carbonate content is moderately high and causes some calcification of debris and silt in the stream bottom. Reduced streamflow, probably due to closure of the forest canopy, occurs throughout the drainage but has most severely effected the tributaries. Persistent flow of this stream, in spite of volume reduction, is probably related to its location in an area of high precipitation rather than to land management activities in the watershed. The ratio of pool, riffle and flat water in Spearfish Creek and the quality of these features is the best in the Black Hills. Riparian vegetation is in good condition throughout most of the drainage and is an important factor in maintaining cool water temperatures. There is no livestock grazing on the mainstem. Grazing is restricted to tributaries where it adversely modifies riparian vegetation. The road along Spearfish Creek is paved and is located a sufficient distance from the stream to limit siltation impacts.

Homestake Mining Company owns most of the Spearfish Creek watershed and has built diversion dams and power plants along the stream. Portions of the stream below these diversion dams are intermittent.

Trout reproduction is abundant in Spearfish Creek, and a population composed mostly of brown trout is present. Total trout populations in some sections are as high as 14,000 fish per mile. To maintain the desired angler success under high fishing pressure, only a few hatchery-reared adult trout are planted. The portion of Spearfish Creek above Cheyenne Crossing is cold enough to retard fish growth rates.

From Cheyenne Crossing to the town of Spearfish the stream is of highest quality (1-a) except for those intermittent portions below diversion dams which are classified as poor quality trout habitat (2-b). At the fish hatchery on the south edge of Spearfish, the stream is again high quality water. It continues as high quality water through town, although there is some dumping of refuse into the creek. Effluents from the sewage treatment plant below town raise stream temperatures and contribute to contamination. These two factors justify down-grading the stream to a 2-b classification (unsuitable for trout). Recovery from this condition occurs due to springs in the stream bottom and partial return of irrigation water to the stream. From U.S. Highway 14 to the Redwater River it is reclassified 2-a and managed for trout.

A few fathead minnows, white suckers and mountain suckers also occur in Spearfish Creek (Stewart and Thilenius 1964) as well as the protected longnose sucker.

Wyoming

The entire Oahe Alternative water supply line through Wyoming would lie in the Belle Fourche River drainage basin. The first stream which would be crossed by this route in Wyoming is Sand Creek (MP 199) in Crook County, just west of the South Dakota-Wyoming state line (Table 74). The closure of the basin's forest canopy and water uptake in the limestone results in the reduced stream flow in Sand Creek (Stewart and Thilenius 1964). Directly upstream from the proposed crossing Sand Creek is a good trout stream with statewide value. The proposed Alternative water supply line would cross Sand Creek just upstream from Beulah, Wyoming. This portion of the stream was rated as Class III waters by the Wyoming Game and Fish Commission (1971). The Class III designation indicates this portion of Sand Creek is a regionally valuable trout resource. According to Red Rocket (1980) of the Wyoming Game and Fish Commission, Sand Creek for its relatively small size, is the most productive trout stream in Wyoming. Brown trout in Sand Creek usually spawn between the end of

Table 74 LOCATION AND FLOW CHARACTERISTICS OF STREAMS AND RIVERS WHICH WOULD BE CROSSED BY THE OAHE ALTERNATIVE THROUGH WYOMING
(MP=Approximate pipeline milepost at proposed crossing; I=Intermittent; P=Permanent; UT=Unnamed Tributary)

| Stream | MP | Flow | County |
|---|---|---|---|
| Sand Creek | 199 | P | Crook |
| South Redwater Creek | 199.5 | P | Crook |
| UT South Redwater Creek | 203 | I | Crook |
| Alkali Creek | 206 | I | Crook |
| South Redwater Creek | 208 | P | Crook |
| Sundance Creek | 210 | P | Crook |
| UT Sundance Creek | 218 | I | Crook |
| UT Beaver Creek | 220.5 | I | Crook |
| UT Beaver Creek | 221.5 | I | Crook |
| UT Beaver Creek | 223 | I | Crook |
| UT Beaver Creek | 225 | I | Crook |
| UT Beaver Creek | 227 | I | Crook |
| Beaver Creek | 228 | I | Crook |
| UT Inyan Kara Creek | 230 | I | Crook |
| UT Inyan Kara Creek | 233 | I | Crook |
| Inyan Kara Creek | 233.5 | P | Crook |
| Arch Creek | 236 | I | Crook |
| Willow Creek | 236.5 | I | Crook |
| Tom Cat Creek | 239 | I | Crook |
| Mule Creek | 241 | P | Crook |
| Wind Creek | 243 | I | Crook |
| UT Wind Creek | 245 | I | Crook |
| UT Wind Creek | 248 | I | Crook |
| Unnamed Stream | 249 | I | Crook |
| UT Belle Fourche River | 249.5 | I | Crook |
| Belle Fourche River | 253 | P | Crook |
| Donkey Creek | 254 | P | Crook |
| UT Donkey Creek | 259 | I | Crook |
| UT Donkey Creek | 259.5 | I | Crook |
| UT Donkey Creek | 260.5 | I | Campbell |
| UT Donkey Creek | 263.5 | I | Campbell |
| UT Donkey Creek | 264 | I | Campbell |
| UT Donkey Creek | 266 | I | Campbell |
| UT Donkey Creek | 267 | I | Campbell |
| UT Donkey Creek | 270.5 | I | Campbell |
| UT Donkey Creek | 272 | I | Campbell |
| UT Donkey Creek | 273 | I | Campbell |

October and mid-November. This fall spawning strategy reduces heavier mortality of eggs and fry associated with spring runoff (Baxter and Simon 1970). The remaining streams which would be traversed by the Oahe Alternative water supply line in Wyoming have only limited sport fishery potential.

### 2.G.2 PUMP STATIONS

The Oahe Alternative pump stations would all be located 1 or more miles away from streams which would be crossed by the pipeline. Four of these 8 pump stations would be in intermittent stream basins. Only 1 of the 4 pump stations located in perennial stream basins would be located in a sensitive area.

The pump station at MP 196 would be located a few miles from Redwater and Sand creeks. These streams sustain populations of threatened fishes and trout, respectively. More detailed discussions of potentially affected streams are presented in Section 2.G.1, above.

## 2.H <u>SLURRY PIPELINE WATER DISCHARGE ALTERNATIVE</u>

### 2.H.1 WATER TREATMENT FACILITIES

Water treatment facilities would be located at the dewatering plants identified in Section 2.A.4, above. The biological characteristics of the potentially affected drainages were discussed in that section, and would be the same for the water treatment facilities.

### 2.H.2 DISCHARGE FACILITIES

Discharge facilities would be located at the dewatering plants identified in Section 2.A.4 , above. The aquatic biological characteristics of the potentially affected drainages were discussed in that section, and would be the same for the discharge facilities.

## 2.I COMBINED WELL FIELD ALTERNATIVE WATER SUPPLY SYSTEM

The affected environment for this alternative would be the same as the Niobrara and Crook County well fields in sections 2.A and 2.F.

## 2.J TREATED WASTEWATER ALTERNATIVE WATER SUPPLY SYSTEM

Streams potentially affected by this alternative include Rapid Creek, the Belle Fourche River, Whitewood Creek, and Box Elder Creek in the Black Hills area of South Dakota. These streams were previously described in Section 2.G of this report.

Chapter 3

# ENVIRONMENTAL CONSEQUENCES

## 3.A PROPOSED ACTION

### 3.A.1 COAL SLURRY PREPARATION PLANTS

#### Construction

The anticipated physical effects of preparation plant construction include stream siltation, nonpoint source pollution, fuel spill hazards, and flow regime alteration (Rogozen et al. 1977, Anderson et al. 1978, EPA 1976). While these various physicochemical disturbances may be expected to reduce macroinvertebrate and fish populations in perennial stream habitats, such impacts would not be expected to be significant in the intermittent or ephemeral streams in the potentially affected areas and there are two major reasons for anticipating this reduced impact significance. First, the indigenous biota of these temporary habitats are generally less abundant and diverse than the biota of permanent streams (Hynes 1970, Williams and Hynes 1977) and are comprised of organisms which exploit these temporarily available habitats by immigrating to them from neighboring permanent waters (Williams 1977, Larimore 1959). Recent investigations completed by Wesche and Johnson (1980) have, in fact, documented both the limited aquatic biological resources and the stressful ambient water quality characteristics of many of the region's streams.

Secondly, the physicochemical effects of construction are anticipated to be limited to those periods when severe rainstorms erode soils and other contaminants into local drainages. The large volumes of runoff associated with these storms would be expected to dilute the various construction site pollutants (primarily petrochemicals) and would probably represent a minor (less than one percent) increase in suspended solids concentrations. Further, the intermittent and short-term nature of such effects would be expected to preclude the possibility of chronic exposure to, or bioaccumulation of, construction site pollutants.

It should also be noted that the physical "scouring" effect of some rainstorms on stream biota (Waters 1972) would probably represent a greater potential impact than construction related impacts.

Sanitary facilities at the preparation plant construction sites would meet applicable state and federal standards and, therefore, would be anticipated to preclude the possibility of significant aquatic biological impacts.

In summary, it is anticipated that construction impacts discussed above would be intermittent, localized, short-term and insignificant.

Operation, Maintenance, and Abandonment

It is anticipated that during the preparation plant operational and maintenance phases nonpoint source pollutants including various quantities of fuels, roadway contaminants, erodible soils and particulate coal fractions would be washed into local drainages, primarily during rainstorms. Local rainfall characteristics generally suggest that the ephemeral and intermittent streams in the area will flow during the high rainfall months of April, May, and June (Ecological Consultants 1976). The temporary fish fauna which may become established in these streams during flowing water periods would experience increased turbidity composed of both soil and coal fractions, and petrochemical contamination. It has been demonstrated that under natural conditions many fishes do not remain in areas of high turbidity and that turbidity tolerant rough fish predominate under these conditions (Peters 1967, Herbert et al. 1961, Burnside 1967). Petrochemical and assorted roadway contaminants would be expected to further stress these temporary fish populations as a result of their potential toxicity.

The temporary and limited macroinvertebrate fauna expected to utilize local ephemeral and intermittent streams (Williams and Hynes 1977) are anticipated to be stressed by the same factors which would be

expected to affect local fishes. Turbidity can decrease invertebrate population densities (Tebo 1955, Williams and Mundie 1978, Allan 1975, Barber and Kevern 1973) alter species composition (Conlan and Ellis 1979, Rosenberg and Wiens 1978) and modify behavior (White and Gammon 1977).

It is likely that the cumulative impact of these factors in conjunction with various pollutants from the operating coal mines would be a reduction in the number of fishes and macroinvertebrates capable of exploiting these temporary habitats. It is not likely, however, that the origin of these various pollutants would be uniquely attributable to either coal mine or preparation plant operation or maintenance procedures. In short, it is anticipated that it would not be possible to distinguish between preparation plant and coal mine pollutants.

The cumulative effects of preparation plant and coal mine nonpoint source pollutants would probably result in decreased macroinvertebrate and fish population densities in the affected temporary streams but would not be anticipated to have a significant impact on biota in the permanent streams to which these temporary streams are tributaries.

It is likely that these population reduction impacts would be detectable in the affected temporary streams for the life of the project. These impacts, however, would probably not result in significant changes in the fish and macroinvertebrate faunas of the perennial rivers and streams in these drainages. In summary, the impacts anticipated to be associated with the operation and maintenance of the coal mines and preparation plants would probably be localized, long-term, and significant.

Fish and macroinvertebrate population recovery would be anticipated within a few years of the termination of operation of the preparation plants and coal mines. In that period of time it is likely that rainstorms would scour the accumulated sediments and pollutants out of the affected stream channels.

The reduction in aquatic organism population levels anticipated to be associated with abandonment procedures would be expected to be localized, short-term, and insignificant since the above-ground structures would be removed and the disturbed land revegetated in a short period of time.

There are no threatened or endangered species which are anticipated to be affected by the construction, operation, maintenance, or abandonment of the proposed preparation plants in Wyoming.

## 3.A.2 WATER SUPPLY SYSTEM

### Construction

Construction of the well field and preparation plant water supply pump station would be expected to increase stream siltation and nonpoint source pollutants in local rivers and streams. Since both the biota and the biological impacts anticipated to be associated with construction activities are similar to those described in Section 3.A.1, above, it is likely that these impacts would be intermittent (associated with rainstorm activity), localized, short-term, and insignificant.

Construction of the water supply pipelines and the well field gathering lines is scheduled during the high rainfall months of March through June (1983). Many of the intermittent and ephemeral streams which would be crossed by the water supply lines may sustain populations of fishes and macroinvertebrates during these high rainfall months but recent investigations have demonstrated that these communities tend to be low in population density and diversity (Wesche and Johnson 1980).

The major effects of pipeline construction in the affected drainages would be siltation caused by trenching near and/or within the 50 ft. ROW streambeds, petrochemical spill complications, and flow regime and habitat alteration. These anticipated effects, of course, would only be expected in stream and river systems under flowing water conditions. In those drainage courses where construction would occur during dry streambed conditions none of these construction effects would result in impacts of any aquatic biological significance.

Pipeline construction through, or within the drainage of, temporary streams with flowing water and established fish and macroinvertebrates communities would have, as state above, siltation, petrochemical spill, flow alteration and habitat alteration effects. The biological impacts associated with these physical effects would probably be the elimination or temporary displacement of a relatively small number of organisms (in comparison to the number of organisms anticipated to be affected in a perennial stream system). Primarily because of the limited density and diversity of temporary stream biota in these Wyoming drainages it is likely that these impacts would be localized, short-term, and biologically insignificant.

The discharge of hydrostatic test water could have significant biological impact as discussed in Section 3.A.3, below.

No significant biological impacts are anticipated to be associated with sanitary waste disposal facilities at the construction sites since these facilities would meet all state and federal standards.

There are no threatened or endangered species which are anticipated to be affected by any construction aspect of the water supply system.

Operation, Maintenance, and Abandonment

Routine operation, maintenance, and abandonment of the proposed water supply system would be anticipated to have no significant aquatic biological impacts. If, however, the water supply pipeline would rupture, or if the regional water table would be lowered as a result of Madison formation drawdown then significant biological impacts would be anticipated.

The main water supply pipeline would carry approximately 30 cfs of water to the Jacobs Ranch mine site from the proposed well field. Since this main line would carry the largest volume of water and represents approximately half of the total water pipeline length, spill impact analyses will focus on this line.

If a pipeline rupture were to occur the severity of the anticipated impacts would depend upon the quantity, quality, and temperature of the water spilled in relation to these same parameters in the affected stream(s). The quality of the Madison formation water would vary over the life of the project and, therefore, estimates of biological impact related to water quality are not possible at this time.

Estimates of biological impact related to water volume (assuming a complete pipeline rupture) and water temperature, however, are possible. A spill of 30cfs volume, or less, in any of the temporary streams crossed by the water supply lines would be anticipated to have no aquatic biological impact if the spill occurred during a dry streambed period.

If, however, a spill occurred during a flowing water period and represented a significant increase in stream discharge volume (e.g. a doubling of volume, or greater) then the biological impacts would be similar to those caused by a local rainstorm. The effects on local fishes would be a reduction or suspension of feeding activity and displacement of some species to areas of preferred flow rates. These impacts would be expected to be localized, short-term, and insignificant.

The effects of such a spill volume on macroinvertebrate populations would be similar to those described for fishes but the extent of impact would be somewhat greater because of their relative immobility. Nevertheless, the anticipated impacts would be considered localized, short-term and insignificant since recovery to pre-spill population levels would be expected in the affected area within a few weeks of pipeline repair as a result of the "drift recolonization" phenomenon (Hynes 1970, Waters 1972, Gore and Johnson 1979).

The temperature of the supply water within the pipeline could play an important role in determining the extent of biological damage associated with spills into flowing temporary streams. The approximate subsurface

soil temperature in Wyoming (estimated from mean annual air temperature) would be 46°F and it is expected that pipeline water would maintain this same temperature during all seasons. If a pipeline rupture were to occur in a stream where stream discharge was less than 30 cfs and ambient water temperature was more than 15°F greater than the pipeline water temperature, it could reasonably be expected that a localized fish and invertebrate kill might occur as a result of "cold shock." This cold shock phenomenon has recently been reported by Burton et al. (1979).

Similarly, if a rupture were to occur in a stream where stream discharge was less than 30 cfs and ambient water temperature was more than 15°F less than the pipeline water temperature, a localized fish and invertebrate kill as a result of "heat shock" may ensue. This heat shock phenomenon has been addressed in a review of thermal effects by Talmage and Coutant (1978).

If aquatic populations were subjected to either heat shock or cold shock it is likely that the effects would be localized, short-term and biologically significant. The temporary nature of the streams which could be subjected to spill effects makes it reasonable to suggest that population recovery would be anticipated within one or two years of pipeline repair.

Streams and rivers in the Black Hills of South Dakota and Wyoming are presently suffering from an over allocation of water rights (Hanten and Talsma 1981). The effects of these over allocations are streams and rivers which have minimum flow requirements for fish and wildlife which often exceed the existing monthly low flows (Glover 1979).

Streams and rivers which traverse the area which could be subjected to surface water flow reductions are listed on Appendix Table A1. For estimated surface flow reductions in streams in this area consult Appendix Table A6. Before stream flow reductions can be predicted, adequate historical gaging data is necessary. Consequently, at the present time, it is possible to predict surface stream flow reductions only in those streams listed in Appendix Table A6. It is not our intention to suggest that these are the only streams and rivers which could be affected but rather that these are the only streams with adequate flow data to estimate quantative reductions in flow. All streams and rivers listed in Appendix Table A1 could be affected by flow reduction but the degree of the severity of these impacts could not be modelled due to the lack of adequate gaging data.

Biological impacts to streams and rivers which could be affected by reduced stream flow were analysed using a worst-case approach. Lack of stream-specific gaging data for streams in the affected area necessitates this worst-case approach.

In generic terms, dewatering of these streams could cause all or some of the following impacts:

- loss of useable aquatic habitat
- loss of suitable spawning areas
- competitive stress
- loss of escape cover
- loss of aquatic vegetation and riparian zones
- water temperature increases and dissolved oxygen reductions
- loss of food supply

Generally, these impacts could result in loss of stream productivity and consequently carrying capacity.

Existing gaging data allowed for the estimation of flow reduction in the Belle Fourche River at the Wyoming-South Dakota state line. Plan 1, the Niobrara Well Field alone, would not reduce surface flows in the Belle Fourche River at the Wyoming-South Dakota state line (Appendix Table A6). Consequently, Plan 1 would not affect this class III fishery resource. Plan 2, a combination of the Niobrara and Gillette Well Fields would reduce the discharge at the state line by 1 cfs. Seven-day-10-year monthly low flows in the Belle Fourche River at the Wyoming-South Dakota state line were reported by Glover (1979) and are listed in Appendix Table A2. Table A2 also lists Glover's recommended 7-day-10-year miminum low flows for the Belle Fourche River at the Wyoming-South Dakota state line. Glover (1979) lists 100 percent of the 7-day-10-year monthly low flow as the recommended minimum flow (Appendix Table A2). Consequently, the 1 cfs reduction resulting from drawdowns in the Madison Formation would reduce flows below recommended levels for each month. According to Hanten and Talsma (1981), violation of minimum flow recommendations would cause significant impacts to the Belle Fourche River fishery. This 1 cfs loss of flow would constitute 71.4 percent of the 7-day-10-year August low flow (Appendix Table A2) when the base flow is only 1.4 cfs.

Adequate gaging data also allows for analysis of impacts to Spearfish Creek (Appendix Table A2). Plan 2 would result in a 1 cfs decrease in stream flow in the entire drainage basin. During January, February, March, October, November and December the 1 cfs loss of surface flow would not reduce flows below Glover's (1979) recommended minimum stream flows. During the remaining months Glover recommends 100 percent of the 7-day-10-year monthly flows as the minimum. The 1 cfs loss during these months constitutes less than 4 percent of the base flow. However, Hanten and Talsma (1981) reported that this relatively small percentage would significantly affect Spearfish Creek's fishery resource.

Plans 3 and 4 could result in a 4 cfs decrease in surface flow in the Belle Fourche River. During the 7-day-10-year low flow period this 4 cfs reduction would cause the Belle Fourche River to dry up (Appendix Tables A3 and A4). Reduction of flows in the Belle Fourche River by 4 cfs would significantly impact aquatic resources in the Belle Fourche River (Hanten and Talsma 1981). Since recovery would require at least 5 years, such impacts must be considered long-term.

Existing data also allows for analysis of potential impacts to the Cheyenne River. Glover has recommended 7-day-10-year low flows for the Cheyenne River at Plainview, South Dakota and at the Cherry Creek confluence (Appendix Table A5). All plans could directly or indirectly reduce base flows in the Cheyenne River. Glover (1979) reports 100 percent of 7-day-10-year low flow as the recommended minimum for all months at both locations. According to Hanten and Talsma (1981), any reduction below the recommended minimum flow in the Cheyenne River would cause long-term, significant impacts to the river's aquatic resources. A 1 cfs decrease in stream flow could cause the annual dry stream bed period in the Cheyenne River, above Angostura Reservoir, to increase from 14 to approximately 33 days. Hanten and Talsma (1981) reported that such an increase would destroy the river's fishery.

## 3.A.C COAL SLURRY PIPELINES AND PUMP STATIONS

### Construction

The physical stream crossing construction effects which would be anticipated to result in aquatic biological impacts will be discussed in a generic way. Specific stream crossings and/or species will be considered only when they require individual treatment in order to adequately assess potential impacts (e.g., threatened or endangered species, major sport fisheries). Although it is obvious that there are differences in taxonomic composition, density, and distribution of aquatic biota in each of the potentially affected streams and rivers, the nature of the various impacts is anticipated to be similar for these fish and invertebrate faunas. The precise extent or severity of anticipated impact would, of course, be expected to vary depending upon specific construction technique (e.g., bedrock blasting vs. trench and fill), physical stream characteristics (e.f., perennial vs. temporary), and biological characteristics (e.g., low density vs. high density faunas). Clearly, for the majority of potential stream crossing locations, these site-specific data are not available. Therefore, various assumptions regarding faunal density and productivity will be made, and the assessment of potential impacts will rely both on these assumptions and the anticipated physiological and ecological similarities among related biota throughout the potentially affected regions.

The anticipated physical effects of slurry pipeline system construction through, and adjacent to, potentially affected rivers and streams include stream siltation, nonpoint source pollution, fuel spill

hazards, and flow regime and habitat alteration (Rogozen et al. 1977, Anderson et al. 1978, EPA 1976). It seems logical to assume that significant aquatic biological impacts would not occur in riverbeds where water is not present during the construction period (although there is a possibility of biological effects during later flowing water periods). Emphasis, therefore, will be placed on the analysis of temporary and permanent streams and rivers which would be expected to sustain established aquatic biological communities during the construction periods.

It is our opinion that nonpoint source pollution, petrochemical spills, and flow regime alteration are construction effects which, generally, would not result in significant aquatic biological impacts. The short period of time required for river crossing construction (from a few hours or days to a few weeks, depending upon river depth and width) would not allow for pollutant concentration at the construction sites. In addition, ETSI has proposed to maintain stream flow at all crossing locations and to refuel heavy equipment outside of river channels, when possible.

The two physical construction effects which would be expected to precipitate detectable biological impacts are stream siltation/turbidity and habitat disturbance (temporary benthic substrate removal and bedrock blasting, in particular).

River crossing construction activities increase sedimentation and turbidity as a result of disturbance or removal of ground cover, heavy equipment traffic, and dredging in the river channel. Cordone and Kelley (1961) and Stern and Stickle (1978) have completed extensive reviews of the literature regarding the biological effects of increased sedimentation and turbidity. It has been found that an increase in sedimentation can affect productivity throughout all trophic levels (Karr and Schlosser 1978, Stern and Stickle 1978, Peters 1967, Cordone and Kelley 1961, Gangmark and Bakkala 1960, and many others).

Although sustained periods of exposure to high suspended solids under laboratory conditions have been shown to cause adult and juvenile fish mortality (Herbert and Merkens 1961, Herbert and Richards 1963, and several studies reported in Stern and Stickle 1978), increases in ventilation (Horkel and Pearson 1966), physical damage to gills and other exposed tissues (Herbert and Merkens 1961, Ellis 1944 in Cordone and Kelley 1961), plus other behavioral effects, it has been shown that under natural conditions (Peters 1967, Herbert et al. 1961, Burnside 1967) fish do not remain in areas of high turbidity. Further, elevated turbidity levels would be anticipated to last for only a few hours after the completion of construction, and to affect a relatively small section of river or stream within approximately 1000 feet (or less) of the dredging activity.

These data suggest that the likely response of affected adult and juvenile fishes to increased turbidity would be temporary emigration from the affected area and this sort of response has been documented in the literature (Gammon 1970). These fishes would be expected to return to the construction areas within a few hours after turbidity levels return to normal. Therefore, it is anticipated that these impacts would be localized, short-term, and insignificant.

The most notable fisheries impact associated with construction-induced turbidity would be a potential reduction in reproductive success. When fine sediment settles on coarse unconsolidated substrates the permeability of those substrates is decreased. When eggs are laid in affected areas water may not flow freely over the eggs which can result in a decrease in hatching success (Meehan and Swanston 1977, Auld and Schubel 1978). Auld and Schubel (1978) found that varying amounts of suspended sediments affected the hatching success of species of fish differently. Less than 1,000 mg/l did not affect the hatching success of yellow perch, blueback herring, alewife or American shad eggs, but 1,000 mg/l significantly reduced the hatching success of white perch and striped bass.

It is also believed that sediment affects the flow of water through gravel, preventing the removal of metabolic waste and entrance of oxygen (Cooper 1965, Sheridan and McNeil 1968, Meehan and Swanston 1977 and others). Shelton and Pollock (1966) found that if 15-30% of the interstices in gravel were filled with sediment, there resulted an 85% mortality of salmon eggs. The sediment may act as a physical barrier to the fry, even if they do hatch successfully. Sedimentation can also disrupt reproduction by covering spawning grounds (Karr and Schlosser 1978), making them unavailable for reproduction.

ETSI has proposed to construct their river crossings "during periods of low flow whenever possible or be timed to eliminate conflicts with critical migration or spawning schedules of any aquatic species." As an example, ETSI has proposed to cross the Arkansas River during August and September 1983. Striped bass migration and spawning "runs" occur during the early spring months in the Arkansas River basin. Their semi-buoyant eggs hatch in a few days and the larvae drift downstream to reservoir nursery areas. This proposed Arkansas River construction schedule would be anticipated to eliminate the possibility of significant impact to striped bass in the basin.

White bass spawn on approximately the same schedule as striped bass in the Arkansas River basin and would also be anticipated to suffer no significant impact as a result of Arkansas River crossing construction.

At those stream and river crossing locations where construction would coincide with fish migration periods, there is a possibility that instream activity would interfere with pre- or post-reproductive migration. Such interference has been reported in the literature (EPA 1976) and the severity of the impact would depend upon the spawning behavior of the species involved, the suspended solids increase anticipated, and the delineation of the downstream area to be affected.

In the smaller streams and rivers where instream construction would be completed in a few days, or less, it is likely that migration would be temporarily suspended. Since most fishes migrate over a period of several days or weeks (Geen et al. 1966), migration would be expected to resume shortly after the completion of construction and the settling of suspended materials.

In wide rivers where construction would last for several weeks and would precisely coincide with initial migration periods, spawning could be limited to unaffected downstream areas. This, however, would be an unlikely impact since construction activity would be confined to a relatively small area along the pipline crossing transect. It is likely that migrating fishes would use unaffected transect areas as migration corridors and would avoid active construction areas along the transect.

In summary, it is anticipated that there would be no significant impact to indigenous fish populations when river crossing construction schedules do not coincide with critical fish migration or spawning activity. If, however, construction coincided with spawning activity it would be likely that egg and larval mortality would be limited to the relatively small affected area (less than 1000 feet downstream) and should be considered a localized, short-term impact with no detectable population level effect.

The primary impacts of stream siltation on aquatic invertebrates would be gill membrane abrasion, smothering, and/or loss of acceptable substrate habitat as a result of substrate in-filling. Casey (1959 as reported in Cordone and Kelley 1961) found that siltation for about 1/4 mile downstream from a dredging operation eliminated macroinvertebrates. There was a 50% reduction in numerical abundance one mile below the dredge. Not only do macroinvertebrate populations decrease when sedimentation increases (Tebo 1955), low level sedimentation can alter species composition (Conlan and Ellis 1979, Rosenberg and Wiens 1978).

Conlan and Ellis (1979) found that a one cm layer of wood waste resulted in a reduction in biomass and the loss of the majority of suspension feeders with the affected area becoming dominated by deposit feeders. Rosenberg and Wiens (1978) noticed that sediment additions resulted in different drift rates for various invertebrates. White and Gammon (1977) reported that increases in suspended solids resulted in increased drift rates to more than double the normal rate. Since an increase in sedimentation results in a decrease in habitat diversity by filling in the substrate interstices, macroinvertebrate standing crop has been found to decrease (Williams and Mundie 1978, Allan 1975, Barber and Kevern 1973).

Mollusks, in addition to insects, may also be adversely affected by stream siltation. Ellis (1936) reported a general increase in mortality of mussels affected by silt, and many species of snails and mussels specifically avoid silt-substrate areas (Pennak 1978).

Regardless of the construction schedule it is anticipated that these invertebrate impacts would be localized, short-term, and significant although full recovery would be expected within six months of construction completion. Rainstorm activity would be anticipated to scour the silt deposits from the natural substrates and, thus, make the substrates available for macroinvertebrate recolonization as reported by Gore and Johnson (1979). There are anticipated to be no secondary impacts on local fishes since they would either feed in unaffected areas or they would feed on available invertebrates in the affected areas.

The number of streams or rivers which would require construction blasting, as a result of a bedrock river bottom, is unknown at the present time. The likely impact would be the killing of aquatic biota in close proximity (distance unknown) to the blasting site. This impact would be considered short-term and locally significant with fish and invertebrate recovery anticipated within a few months of the completion of construction.

A more routine river crossing construction technique would be the "trench and fill" method described by ETSI. Assuming that there would be a 100 foot right-of-way at each crossing location, there would be a temporary loss of 111 square yards of benthic substrate for each 10 feet of river crossed.

Unless construction were to coincide with critical spawning periods, no significant impacts on adult and juvenile fishes would be anticipated. If construction coincided with spawning activity and eggs/larvae were present in the right-of-way substrate, they would be killed as a result of being discarded with the dredge spoil. This impact would be considered localized, short-term, and significant, but it is not likely that population density would be detectably affected.

Regardless of the construction schedule it is anticipated that a large volume of macroinvertebrates would be killed as a result of dredging. Data summarized from Neves (1979), Bane and Lind (1978), and Ragland (1974) suggest that "typical" freshwater benthic invertebrate dry weight estimates range from 0.02 to 0.60 oz/yd$^2$, when appropriately converted. For assessment purposes a mean dry weight biomass of 0.50 oz/yd$^2$ has been assumed for all potentially affected macroinvertebrate populations. For each 10 ft (111 yd$^2$) of river crossed the dry weight of eliminated benthic invertebrates would equal approximately 3.5 pounds. Table 75 summarizes the projected invertebrate biomass loss of invertebrates as a result of construction. This impact would be considered localized, short-term and significant although macroinvertebrate recolonization of the right-of-way would be anticipated within a few months of the completion of construction (Gore and Johnson 1979).

The anticipated secondary impacts of invertebrate removal on fishes which rely on them as a food source are summarized in Table 75. This summary assumes that a fish would be approximately 15% efficient

Table 75 ESTIMATES OF MACROINVERTEBRATE AND EQUIVALENT FISH FLESH BIOMASS WHICH MAY BE LOST AS A RESULT OF RIVER CROSSING CONSTRUCTION

| River Width (feet) | Macroinvertebrate Biomass (lbs, dry weight) | Fish Biomass (lbs, dry weight) |
|---|---|---|
| 10 | 3.5 | 0.5 |
| 20 | 7.0 | 1.0 |
| 30 | 10.5 | 1.5 |
| 40 | 14.0 | 2.0 |
| 50 | 17.5 | 2.5 |
| 100 | 35.0 | 5.0 |
| 200 | 70.0 | 10.0 |
| 500 | 175.0 | 25.0 |
| 1000 | 350.0 | 50.0 |
| 2000 | 700.0 | 100.0 |
| 5000 | 1750.0 | 250.0 |

Note: See text for discussion of assumptions.

in converting its food to flesh (Russell-Hunter 1970). It should be noted that a 15% estimate is liberal. These data indicate that approximately 0.50 dry weight pounds of fish flesh would be lost for every 10 feet of river crossed. This secondary impact on local fishes would be localized, short-term, and of limited biological significance since these fishes would be expected to simply move a short distance upstream or downstream in order to feed.

The discharge of untreated hydrostatic test water may increase stream turbidity, decrease dissolved oxygen, and increase iron, oil, and grease concentrations in receiving waters. In addition, the physical result of a large volume instantaneous discharge in a small perennial stream would be "scouring" of the stream bottom and banks which could displace affected fishes and invertebrates to downstream locations or, in severe cases, wash them out of the stream channel.

The biological impacts associated with increased turbidity were described above.

The effects of iron concentrations on freshwater aquatic life have been summarized and a water quality criterion of 1.0 mg/l has been established for the protection of freshwater biota (EPA 1976). Untreated hydrostatic test water may have concentrations as high as approximately 13 mg/l which would be anticipated to have various lethal and/or sub-lethal impacts on affected biota in streams where stream volume would not be sufficient to dilute the concentration to 1.0 mg/l or less.

While detailed criteria for concentrations of oil and grease can only be established for specific water bodies, species, and oil or grease types, it can be generally stated that even an oily sheen on the water surface may be evidence of potentially lethal impacts on affected biota (EPA 1976).

Decreased dissolved oxygen concentrations in receiving waters would stress affected biota and could kill some sensitive species if concentrations were reduced to 5.0 mg/l or less (EPA 1976). The cumulative impact of these biological effects in low volume streams or rivers could be a localized "kill" affecting most trophic levels. Recovery of the affected stream or river would be expected within two years (if oil and/or grease do not accumulate in the stream's sediments) as a result of repopulation from unaffected contiguous streams.

Threatened and endangered species which are distributed in proximity to the proposed slurry pipeline system are discussed in the Threatened and Endangered Species Technical Report. Only one species is considered endangered by the USFWS; the fat pocketbook pearly mussel. The Arkansas darter is considered threatened in Kansas.

No significant aquatic biological impacts would be associated with sanitary waste disposal facilities since all state and federal regulations would be met.

Operation, Maintenance, and Abandonment

The only potentially significant aquatic biological impacts anticipated to be associated with routine operation, maintenance, and abandonment procedures would be associated with the use of herbicides on the pipeline ROW and associated facilities. All other routine procedures as outlined in the project description would probably have no detectable impact on aquatic biota. The potential impacts of coal slurry spills will be addressed as a "non-routine" occurrence in a variety of sensitive aquatic habitats in the Ruptures and Spills Technical Report.

The aquatic biological effects of herbicides have not been extensively studies but, in general, herbicides are considered to be less toxic to aquatic biota than pesticides (Bushnell 1974). Nevertheless, toxicity varies depending on in-stream concentration; type of herbicide;

water temperature, hardness, and pH; season; affected species; application proximity to river or stream; soil porosity; and other factors. Effects of the toxicity of herbicides to fishes have been reported by Crosby and Tucker (1966), Holden (1972), and Pravda (1973). Kenk (1974) and Bushnell (1974) have reviewed data regarding herbicide effects on aquatic invertebrates and, like the fisheries investigations, have indicated variable results.

These authors, and others (Boyle 1980, Ramsay and Fry 1976, Harp and Campbell 1964, Brooker and Edwards 1974, Watson 1977), have reported (1) both increases and decreases in aquatic productivity throughout trophic levels, (2) lethal and sub-lethal effects on fishes, (3) the capability of floods to "scour" herbicides out of river channels and sediments, and (4) the bioaccumulation potential of various types of herbicides.

Since ETSI has proposed to use only state and federally approved biochemicals, and would apply them by acceptable ground techniques, it is likely that the potential for detectable aquatic biological impacts would be minimized.

## 3.A.4 DEWATERING PLANTS

### Construction

It is anticipated that general construction activity associated with the proposed dewatering facilities would result in physicochemical effects to local drainage systems including stream siltation, nonpoint source pollution, and fuel spill hazards (Rogozen et al. 1977, Anderson et al. 1978, EPA 1976). The potentially affected water bodies were identified and described in Section 2.A.4, above.

It is anticipated that sediment and chemical contributions would occur periodically, primarily during rainstorms, for the duration of the one or two years scheduled to construct each of the dewatering

plants. It is important to note, however, that the various construction effects could be "masked" by the related power plant construction or operation effects anticipated at each dewatering plant site.

The biological effects of increased stream siltation were described in Section 3.A.3, above. The effects of nonpoint source pollutants and petrochemical spills would be anticipated to be ameliorated by the large volumes of rainstorm runoff which could carry these pollutants to the stream and river channels and, in conjunction with the large volumes of water in the affected drainages, would probably dilute them to "trace" concentrations.

The biological impact to local fish and invertebrate populations would be limited to river areas from the point of entrance of the pollutant to the river, to the downstream location where the suspended material settles out of the water column. Anticipated adult and juvenile fish impacts would be intermittent, localized, short-term and insignificant primarily because of the anticipated dilution effect and the tendency of many fishes to avoid concentrated areas of high turbidity (Peters 1967, Burnside 1967, Gammon 1970). The impacts of increased pollutant and sediment loads on fish spawning grounds, eggs, and larvae were discussed in Section 3.A.3, above and it is anticipated that the same types of impacts may be associated with dewatering plant construction effects. The anticipated impacts on reproductive success would be localized, short-term and biologically insignificant to the fish populations in the affected water bodies, even though a relatively small number of eggs and larvae may be killed as a result of construction effects.

The impact of an increased sediment load on aquatic macroinvertebrate populations would probably be a reduction in productivity and a species composition change favoring silt-tolerant invertebrates. These impacts would be considered locally significant but macroinvertebrate population recovery would be expected within one or two years of the completion of construction.

The biological impacts associated with sediment and pollutant impacts to Castor Lake (Boyce Site) would be evidenced throughout a larger area than affected stream systems, and would modify the reservoir habitat for a longer period of time since there would be no constant currents to scour the substrate or dilute the contaminants. The potential for sediment and chemical concentration exists and would be expected to reduce macroinvertebrate and fish productivity in the affected area. Since operation, maintenance, and abandonment procedures would also be anticipated to result in reservoir contamination (discussed below) recovery of the affected reservoir area would be likely to occur only after the abandonment of the project.

The only threatened or endangered species which would be anticipated to be affected by construction of the proposed dewatering facilities is the fat pocketbook, a freshwater mussel considered endangered by the U.S. Fish and Wildlife Service. This species is discussed in the Threatened and Endangered Species Technical Report.

Operation, Maintenance, and Abandonment

As a result of the operation and maintenance of the dewatering plants, various nonpoint source pollutants including petrochemicals and particulate coal factions would be expected to enter the drainages identified in Section 2.A.4, above, regardless of the precautions taken to avoid such contamination. It should be noted that these types of pollutants would be expected from the operating utility stations served by the dewatering facilities and, therefore, it is unlikely that biological impacts could be specifically attributed to either source. Details regarding the impacts of particulate coal on aquatic biota are presented in the Ruptures and Spills Technical Report. For the purposes of this document it is sufficient to indicate that the various anticipated physical effects would be similar to those associated with naturally occurring suspended solids. These impacts have been discussed in Section 3.A.3, above.

It is anticipated that due to the dilution effects and intermittent nature of these pollutant contributions there would be no significant fish population impacts in the affected water bodies even though some fish eggs and larvae may be killed if water body contamination were to coincide with spawning activity.

The result of these pollutant loads to macroinvertebrates would be a reduction in density and diversity in the affected river or lake substrates. The affected area would be from the point of pollutant entrance to the water body, to that location where particulate materials settle out of the water column and chemical pollutants are sufficiently diluted to eliminate the possibility of biological effects. That precise distance will vary with rainfall, stream and lake conditions, dewatering plant operations, and other parameters. These impacts would be considered localized, significant, and biologically detectable for the life of the project. It is unlikely that there would be any detectable, complementary effect on the fishes (and other invertebrates) which feed on these benthic communities since they would probably either move to an unaffected area in order to forage, or they would forage on available invertebrates in the affected areas.

The effects on aquatic biota associated with abandonment of the dewatering plants are anticipated to be similar to those identified in Section 3.A.3 for the affected organisms, except that the duration of the impacts would be for a shorter period of time.

The fat pocketbook pearly mussel is considered endangered by the U.S. Fish and Wildlife Service and is discussed in the Threatened and Endangered Species Technical Report.

### 3.A.5 ANCILLARY FACILITIES

Construction

Ancillary facilities include communication towers and transmission lines. Primarily due to the short period of time required for construction of such structures (e.g., one day for transmission line poles), the small area which would be disturbed, and their proximity to areas which would be disturbed by other project components, it is unlikely that detectable aquatic biological impacts would result from such construction activities.

Operation, Maintenance, and Abandonment

It is anticipated that there would be no detectable aquatic biological impacts associated with the operation, maintenance or abandonment of ancillary facilities since these activities would be outside of stream channels and would require a minimum of terrestrial habitat disturbance within the drainage basins.

## 3.B MARKET ALTERNATIVE

### 3.B.1 COAL SLURRY PREPARATION PLANTS

The aquatic biological impacts anticipated to be associated with construction, operation, maintenance, and abandonment of the market alternative coal slurry preparation plants would be identical to those described in Section 3.A.1, above.

### 3.B.2 WATER SUPPLY SYSTEM

The aquatic biological impacts anticipated to be associated with construction, operation, maintenance, and abandonment of the market alternative water supply system would be identical to those described in Section 3.A.2, above.

## 3.B.3 COAL SLURRY PIPELINES AND PUMP STATIONS

### Construction

The market alternative coal slurry pipeline route would be the easternmost route through Wyoming, Nebraska, Kansas, and Oklahoma. It would join the proposed action pipeline route in Arkansas (market alternative MP 493.5) and follow it to its various power plant markets in Arkansas and Louisiana.

The aquatic biological impacts associated with construction of this alternative slurry line would be expected to be similar in nature and extent to those described in Section 3.A.3, above. The biota which would be affected, however, would be limited to those taxa identified in Section 2.B.3, above.

The trout fisheries in the Niobrara and North Platte Rivers are of special concern to the state of Nebraska. The construction schedule for the North Platte River indicates that it would be crossed during August/early September 1982. This schedule would avoid both the fall and spring spawning seasons and, thus, would minimize impacts on indigenous trout populations.

The fat pocketbook mussel, considered endangered by the U.S. Fish and Wildlife Service, is discussed in the Threatened and Endangered Species Technical Report.

### Operation, Maintenance, and Abandonment

As indicated in Section 3.A.3, above, the only potential aquatic biological impacts anticipated to result from routine operation, maintenance, and abandonment procedures would be associated with the application of herbicides to the pipeline right of way. Potential impacts were discribed above.

3.B.4 DEWATERING PLANTS

Construction

It is anticipated that general construction activity associated with the market alternative dewatering plants would result in physicochemical effects identified in Section 3.A.4, above. The biology of the potentially affected water bodies was described in Section 2.B.4, above.

The aquatic biological impacts anticipated to be associated with these various physicochemical effects would be similar in nature and extent to those described in Section 3.A.4, above.

Operation, Maintenance, and Abandonment

The aquatic biological impacts associated with the operation, maintenance, and abandonment of the market alternative dewatering plants were generically described in Section 3.A.2, above, and would be expected to similarly affect the biota described in Section 2.B.4, above.

3.B.5 ANCILLARY FACILITIES

Construction

Primarily due to the short period of time required for construction of ancillary facilities (e.g., one day for transmission line poles), and their proximity to areas which would be disturbed by other project components, it is unlikely that detectable aquatic biological impacts would result from such construction activities.

Operation, Maintenance, and Abandonment

It is anticipated that there would be no detectable aquatic biological impacts associated with the operation, maintenance, or abandonment of ancillary facilities since these activities would be outside of

stream channels and would require a minimum of terrestrial habitat disturbance within the drainage basins.

## 3.C PIPELINE-BARGE ALTERNATIVE

### 3.C.1 COAL SLURRY PREPARATION PLANTS

The aquatic biological impacts anticipated to be associated with construction, operation, maintenance, and abandonment of the pipeline-barge alternative coal slurry preparation plants would be identical to those described in Section 3.A.1, above.

### 3.C.2 WATER SUPPLY SYSTEM

The aquatic biological impacts anticipated to be associated with construction, operation, maintenance, and abandonment of the pipeline-barge alternative water supply system would be identical to those described in Section 3.A.2, above.

### 3.C.3 COAL SLURRY PIPELINE AND PUMP STATIONS

#### Construction

The pipeline-barge alternative slurry pipeline system would follow the same alignment as the market alternative slurry pipeline system to the White Bluff, Arkansas site. It is anticipated, therefore, that the aquatic biological impacts associated with this project component would be similar to those described in Sections 3.B.3 and 3.A.3, above. In addition, impacts on the aquatic biota of the streams and rivers which would be crossed by the Cypress Bend lateral would be anticipated to be similar in nature and extent to those identified in Sections 3.A.3 and 3.B.3, above.

Operation, Maintenance, and Abandonment

The only potentially significant aquatic biological impacts anticipated to be associated with routine operation, maintenance, and abandonment procedures would be associated with the use of herbicides on the pipeline ROW and associated facilities. A general discussion of herbicide effects was presented in Section 3.A.3, above.

3.C.4 DEWATERING PLANTS

Construction

The general construction impacts associated with dewatering plants were identified in Section 3.A.4, above, and would be expected to be similar in nature and extent for the pipeline-barge alternative dewatering plants. The potentially affected water bodies were identified in Section 2.C.4, above.

Operation, Maintenance, and Abandonment

The aquatic biological impacts associated with the operation, maintenance, and abandonment of the pipeline-barge alternative dewatering plants were generically described in Section 3.A.4, above, and would be expected to similarly affect the biota described in Section 2.C.4, above. Additionally, however, the Cypress Bend dewatering plant would discharge its clariflocculator (slurry water) overflow to the Mississippi River. Since this effluent would be required to meet NPDES water quality standards it is anticipated that there would be no detectable aquatic biological impact associated with the Cypress Bend dewatering plant discharge.

3.C.5 BARGE-LOADING FACILITY

Construction

Construction of the barge loading facility would progress in stages and would extend over a period of 7 years (1982-1989). No dredging would be required and the riverward dock face would be approximately 3000 feet long. It is anticipated that indigenous adult and juvenile fishes (Section 2.C.5) would avoid the construction area, at least during construction activity. This displacement impact would be localized, intermittent (recurring during periods of construction activity), and biologically insignificant since affected fishes would quickly reestablish in disturbed areas.

The primary physical effect of in-river construction activity, which would be anticipated to affect fish eggs and larvae, would be increased turbidity. The general biological impact of increased turbidity and siltation on fish eggs and larvae was described in Section 3.A.3, above, and would be expected to be similar for the Mississippi fish fauna. ETSI's proposal to avoid construction dredging would be expected to minimize egg and larval mortality as a result of substrate in-filling and smothering. Nevertheless, some mortality would be expected, but the impact would probably be localized and biologically insignificant on a population level.

Benthic substrates and their invertebrate communities would be destroyed/displaced where piles would be driven into the riverbed. This would be a locally significant (limited to the construction area), short-term biological impact. It is anticipated, however, that a positive impact associated with the barge facility support columns would be their colonization by communities of aquatic invertebrates shortly after their placement in the river.

The potential for petrochemical spills exists on all construction sites. It is anticipated that low volume spills originating from construction activities and equipment would have a limited, generally

insignificant impact. Contamination of the Mississippi River by spilled materials would occur primarily during rainstorms when they would be washed into the river through natural drainage channels. Since aromatics are generally the most lethal portion of these petroleum products, spills on land would lose their most volatile (i.e., toxic) components to evaporation before reaching the river. Further, spills directly into the river would be expected to be well-diluted by it.

No significant aquatic biological impacts would be anticipated to be associated with sanitary waste disposal facilities since all applicable state and federal standards would be met.

No threatened or endangered species are anticipated to be affected by construction of the barge loading facility.

Operation, Maintenance, and Abandonment

According to the ETSI barge consultant, Meece Marine Enterprises, Inc., there would be no need for maintenance dredging at the barge loading facility. It is notable that maintenance dredging is considered to be the most significant impact associated with barge facilities and, as such, its elimination from the maintenance routine for ETSI's facility suggests that there would be no significant aquatic biological impacts associated with the routine operation and maintenance of the facility.

Two towboats per day would be used for coal transport and this would represent an increase in 9 ft. draw towboat traffic of approximately 17% in the lower Mississippi River (Army Corps of Engineers 1977). The physical effects and biological impacts of large river barge traffic have been recently investigated.

Sparks (1975) found that there were measurable turbidity "trails" behind large river tows. Turbidity increased by 100 JTU's following passage of a tow, returning to normal in about 2-1/2 hours. The Mississippi River has an average turbidity of over 300 mg/l (Platinum wire turbidity; Ragland 1974) or 300 JTU (Jackson turbidity units; Army Corps of Engineers 1976). Increases in turbidity from ETSI tow traffic in the lower Mississippi River would probably be insignificant due to the naturally elevated ambient turbidity conditions and the low number of daily tows (1-2 ETSI tows per day). In addition, Johnson (1976) found that during normal pool conditions increases in turbidity as a result of tow traffic were small compared with ambient levels during flood stage conditions for the upper Mississippi River.

Wave wash as a result of barge river towboat traffic has received some attention by various state and federal biologists. As a towboat passes a point three successive effects are noted (Sparks 1975). The first is a slight increase in the water level and then, following quickly, a rapid decrease in water level of approximately 1.5 feet at the shoreline. If there is a shallow slope on shore a considerable portion of the river bottom is exposed. As the stern passes the water rushes back in a series of waves. Narrow points with sloping shorelines will have a more pronounced wave action. A towboat can alter the rate and direction of flow inside channels.

The drawdown would expose benthic organisms along the shoreline. Mollusks would withdraw into their shells when exposed with a resultant disruption of feeding and respiration. The other possibility is that the mollusks would burrow deeper into the mud or retreat to deeper waters. These effects would normally be short-term and be of limited impact.

Fishes would probably not be affected by wave wash, as they would be able to leave the affected area and are normally subjected to wave action (Sparks 1975).

The proposed barge route is confined to the lower Mississippi River. Since the effects from wave wash are more significant on shallow and narrow rivers, wave wash on the deeper portions of the lower Mississippi River would be expected to be biologically insignificant.

Towboat operation spill hazards would, generally, be associated with barge traffic accidents. The Army Corps of Engineers (1976) suggests that an increase in river traffic does not necessarily result in an increase in barge accidents. The biological impacts of a coal slurry spill in the Mississippi River will be analyzed when physical spill data are available. It is anticipated that a barge coal spill will have many similar effects and they will be discussed in the slurry spill analyses.

### 3.C.6 ANCILLARY FACILITIES

#### Construction

It is anticipated that no detectable aquatic biological impacts would result from the construction of ancillary facilities for the reasons cited in Section 3.A.5, above.

#### Operation, Maintenance, and Abandonment

It is anticipated that no detectable aquatic biological impacts would result from the operation, maintenance, or abandonment of ancillary facilities for the reasons cited in Section 3.A.5, above.

## 3.D COLORADO ALTERNATIVE

### 3.D.1 COAL SLURRY PIPELINES AND PUMP STATIONS

#### Construction

Construction of the Colorado Alternative slurry pipeline system in Wyoming, Colorado, and Kansas (spreads I and II) would extend from May 1983 to June 1984, and may coincide with peak spawning activity in some of the affected drainages. The potentially affected biota were described in Section 2.D.1, above and would be anticipated to be affected as identified in the generic discussion of impacts in Section 3.A.3, above.

The plains orangethroat darter and the Topeka shiner may be affected by the slurry pipeline system in Colorado and Kansas, respectively. These fishes are discussed in the Threatened and Endangered Species Technical Report.

#### Operation, Maintenance, and Abandonment

The only potential aquatic biological impacts anticipated to result from routine operation, maintenance, and abandonment procedures would be associated with the use of herbicides on the pipeline right of way, as discussed in Section 3.A.3, above.

### 3.D.2 ANCILLARY FACILITIES

#### Construction

No detectable aquatic biological impact would be anticipated to be associated with construction of the ancillary facilities for the reasons cited in Section 3.A.5, above.

Operation, Maintenance, and Abandonment

No detectable aquatic biological impact would be anticipated to be associated with operation, maintenance, or abandonment procedures for the ancillary facilities for the reasons cited in Section 3.A.5, above.

## 3.E COAL CLEANING OPERATION ALTERNATIVE

### 3.E.1 CONSTRUCTION

Construction of the coal cleaning facilities would be anticipated to be built on, or adjacent to, the coal slurry preparation plant sites. Since these sites, identified in Section 2.A.1, above, would be disturbed by preparation plant construction activities it would be unlikely that this alternative would additionally affect the aquatic biota to any significant degree. Additional reasons for this conclusion are detailed in Section 3.A.1, above.

### 3.E.2 OPERATION, MAINTENANCE, AND ABANDONMENT

The coal slurry preparation plant impacts identified in Section 3.A.1, above, would be further aggravated by the rejection of at least 200 tons/year of particulate coal from each of the facilities as a result of the coal cleaning operation. The cumulative impact of this alternative in conjunction with preparation plant and mine impacts would probably be a reduction in the number and diversity of invertebrates using the affected stream habitats which would result in a complementary reduction in the abundance and diversity of fishes.

Details regarding these anticipated impacts were discussed in Section 3.A.1, above.

No detectable aquatic biological impacts would be anticipated as a result of abandonment procedures since the above-ground structures would be removed and the disturbed land revegetated in a short period of time.

## 3.F CROOK COUNTY ALTERNATIVE

### 3.F.1 WATER WELLS

#### Construction

Although the precise locations of the wells within the Crook County well field are unknown, the physical and biological characteristics of the potentially affected streams (see Section 2.F.1, above) indicate that anticipated impacts would be localized, short-term, and insignificant. For a thorough discussion of construction impacts in intermittent Wyoming drainages see Section 3.A.1, above. The impacts associated with Crook County water well construction would be anticipated to be similar.

#### Operation, Maintenance, and Abandonment

It is anticipated that operation of the Crook County well field, in conjunction with other planned water uses, could reduce the discharge of the Little Missouri River by approximately 1 cfs. Flow duration data indicate that the Little Missouri River experiences 0 discharge during "dry" years and maintains low flows during the late summer and fall months during most years. A 1 cfs decrease in discharge would not be expected to significantly affect aquatic biota during "normal" rainfall years since the Little Missouri fauna are adapted to natural low flow and even intermittent conditions. During "dry" years, however, a 1 cfs discharge decrease could significantly lengthen the period of time that the streambed would be dry. The anticipated biological impact would be the temporary displacement of affected biota to downstream or tributary areas with sufficient water to maintain life. It is anticipated that the streambed would be recolonized from these temporary refuges when flow would resume in the Little Missouri channel. This impact would be considered short-term and insignificant primarily because intermittent flow is a natural condition in the Little Missouri River.

Operation of the Crook County Well Field could affect any or all of the streams listed in Appendix Table A1. Impacts to the Belle Fourche River would be the same as previously described in Section 3.A.2, above. Although estimates of flow reductions in other affected streams can not be made, because of the severe dewatering conditions occurring in Black Hills streams, any additional loss of surface flow is considered a significant and long-term biological impact (Hanten and Talsma 1981).

Other routine operations, maintenance, and abandonment procedures could not be expected to significantly affect aquatic biota.

## 3.F.2 GATHERING PIPELINES

### Construction

Although precise gathering line locations are not known the potential construction impacts can be addressed generically.

Construction of the well field gathering line is scheduled during the high rainfall months of May and June (1983). Many of the intermittent and ephemeral streams which would be crossed by these lines may sustain populations of fishes and macroinvertebrates during these high rainfall months but recent investigations have demonstrated that these communities tend to be low in population density and diversity.

The major effects of pipeline construction in the affected drainages would be siltation caused by trenching near and/or within the 50 ft right-of-way streambeds, petrochemical spill complication, and flow regime and habitat alteration. These anticipated effects, of course, would only be expected in stream and river systems under flowing water conditions. In those drainage courses where construction would occur during dry streambed conditions none of these construction effects would result in impacts of any aquatic biological significance.

Pipeline construction through, or within the drainage of, temporary streams with flowing water and temporary fish and macroinvertebrates communities would have, as stated above, siltation, petrochemical spill, flow alteration and habitat alteration effects. The biological impacts associated with these physical effects would probably be the elimination or temporary displacement of a relatively small number of organisms (in comparison to the number of organisms anticipated to be affected in a perennial stream system). Primarily because of the limited density and diversity of temporary stream biota in these Wyoming drainages it is likely that these impacts would be localized, short-term, and biologically insignificant.

The discharge of untreated hydrostatic test water could result in impacts described in Section 3.A.3, above.

There are no threatened or endangered species which would be anticipated to be affected by the gathering pipelines.

<u>Operation, Maintenance, and Abandonment</u>

Routing operation, maintenance, and abandonment of the gathering pipelines would be anticipated to have no significant aquatic biological impacts. If, however, a gathering line ruptured then significant biological impacts could occur and these impacts have been generically addressed in Section 3.F.4, below.

### 3.F.3 PUMP STATION

<u>Construction</u>

The pump station would be constructed during the low rainfall months of August 1982 to February 1983. Since streams in the vicinity of the pump station are temporary it would be likely that they would be dry during this period and, therefore, no significant aquatic biological impacts would be anticipated.

<u>Operation, Maintenance, and Abandonment</u>

No significant aquatic biological impacts would be anticipated as a result of routine operation, maintenance, and abandonment procedures. The pump station would not be located in close proximity to any permanent streams and it would require only a small workforce for operation and maintenance.

No detectable aquatic biological impacts would be anticipated as a result of abandonment procedures since the above-ground structures would be removed and the disturbed land revegetated in a short period of time.

### 3.F.4 DELIVERY PIPELINE

Construction

Construction of the delivery pipeline is scheduled during the high rainfall months of March through June (1983). Many of the intermittent and ephemeral streams which would be crossed by the water supply lines may sustain populations of fishes and macroinvertebrates during these high rainfall months but recent investigations have demonstrated that these communities tend to be low in population density and diversity (see Sections 2.A.2 and 2.F.4, above).

The major effects of pipeline construction in the affected drainages would be siltation caused by trenching near and/or within the 50 ft right-of-way streambeds, petrochemical spill complications, and flow regime and habitat alteration. These anticipated effects, of course, would only be expected in stream and river systems under flowing water conditions. In those drainage courses where construction would occur during dry streambed conditions none of these construction effects would result in impacts of any aquatic biological significance.

Pipeline construction through, or within the drainage of, temporary streams with flowing water and established fish and macroinvertebrates communities would have, as stated above, siltation, petrochemical spill, flow alteration and habitat alteration effects. The biological impacts associated with these physical effects would probably be the elimination or temporary displacement of a relatively small number of organisms (in comparison to the number of organisms anticipated to be affected in a perennial stream system). Primarily because of the limited density and diversity of temporary stream biota in these Wyoming drainages it is likely that these impacts would be localized, short-term, and biologically insignificant.

The discharge of untreated hydrostatic test water could result in biological impacts described in Section 3.A.3, above.

There are no threatened or endangered species which are anticipated to be affected by construction of the delivery pipeline.

Operation, Maintenance, and Abandonment

Routine operation, maintenance, and abandonment of the delivery pipeline would be anticipated to have no significance on the aquatic biota described in Section 2.F.4, above. If the pipeline were to rupture, however, significant biological impacts would be anticipated.

The delivery pipeline would transport approximately 30 cfs of water to the North Rawhide preparation plant site from the Crook County well field. If a pipeline rupture were to occur the severity of the anticipated impacts would depend upon the quantity, quality, and temperature of the water spilled in relation to these same parameters in the affected stream(s). The quality of the Madison formation water would vary over the life of the project and, therefore, estimates of biological impact related to water quality are not possible at this time.

Estimates of biological impact related to water volume (assuming a complete pipeline rupture) and water temperature, however, are possible. A spill of 30cfs volume, or less, in any of the temporary streams crossed by the water supply lines would be anticipated to have no aquatic biological impact if the spill occurred during a dry streambed period.

If, however, a spill occurred during a flowing water period and represented a significant increase in stream discharge volume (e.g. a doubling of volume, or greater) then the biological impacts would be similar to those caused by a local rainstorm. The effects on local fishes would be a reduction or suspension of feeding activity and displacement of some species to areas of preferred flow rates. These impacts would be expected to be localized, short-term, and insignificant.

The effects of such a spill volume on macroinvertebrate populations would be similar to those described for fishes but the extent of impact would be somewhat greater because of their relative immobility. Nevertheless, the anticipated impacts would be considered localized, short-term and insignificant since recovery to pre-spill population levels would be expected in the affected area within a few weeks of pipeline repair as a result of the "drift recolonization" phenomenon (Hynes 1970, Waters 1972, Gore and Johnson 1979).

The temperature of the supply water within the pipeline could play an important role in determining the extent of biological damage associated with spills into flowing temporary streams. The approximate subsurface soil temperature in Wyoming (estimated from mean annual air temperature) would be 46°F and it is expected that pipeline water would maintain this same temperature during all seasons. If a pipeline rupture were to occur in a stream where stream discharge was less than 30cfs and ambient water temperature was more than 15°F greater than the pipeline water temperature, it could reasonably be expected that a localized fish and invertebrate kill might occur as a result of "cold shock." This cold shock phenomenon has recently been reported by Burton et al. (1979).

Similarly, if a rupture were to occur in a stream where stream discharge was less than 30 cfs and ambient water temperature was more than 15°F less than the pipeline water temperature, a localized fish and invertebrate kill as a result of "heat shock" may ensue. This heat shock phenomenon has been addressed in a review of thermal effects by Talmage and Coutant (1978).

If aquatic populations were subjected to either heat shock or cold shock it is likely that the effects would be localized, short-term and biologically significant. The temporary nature of all but one of the streams which could be subjected to spill effects makes it reasonable to suggest that population recovery would be anticipated within one or two years of pipeline repair.

While these various temperature-related impacts could realistically occur in perennial Cottonwood Creek (MP 29), it is unlikely that they would occur at the temporary stream crossing locations since these streams would not be flowing in the late summer and winter months when heat and cold shock could most seriously affect local biota.

No threatened or endangered species would be anticipated to be affected by the operation, maintenance, or abandonment of the delivery pipeline.

### 3.F.5 ACCESS ROADS

#### Construction

ETSI has proposed to use existing roadways whenever possible. In addition, the temporary nature of the majority of streams and rivers in the vicinity of the Crook County alternative project components suggests that construction impacts would be intermittent (limited by rainstorm activity and runoff), localized, and insignificant since they would probably be "masked" by the scouring effect of rainstorms.

#### Operation, Maintenance, and Abandonment

It is anticipated that the only potentially significant aquatic biological impacts associated with the operation, maintenance, and abandonment of the access roads would be the result of contamination of streams and rivers by various roadway contaminants. Since these contaminants would be carried to temporary waterways primarily during rainstorms it would be anticipated that they would exist in limited concentrations due to the dilutional effect of large volumes of runoff. It is anticipated, therefore, that biological impacts would be intermittent, localized, and biologically insignificant in the affected intermittent and ephemeral streams.

### 3.F.6 TRANSMISSION LINE NETWORK

Construction

Since construction of the transmission line network would disturb such a small terrestrial area, require such a limited amount of time, and be within an area dominated by temporary streams it is anticipated that aquatic biological impacts including siltation would be intermittent, localized, and biologically insignificant.

Operation, Maintenance, and Abandonment

Unless herbicides would be used on the transmission line ROW, no significant aquatic biological impacts would be anticipated as a result of routine operation and maintenance. Since such a small area would be disturbed as a result of transmission line network abandonment it would be anticipated that aquatic biological inpacts including abandonment-related siltation would be intermittent, localized and insignificant.

## 3.G OAHE ALTERNATIVE

### 3.G.1 PIPELINE

Construction

Construction of an intake structure in the Oahe Reservoir may disturb or eliminate some shoreline (shallow water) and deep water vegetation which often functions as breeding or nursery habitat for indigenous fishes and macroinvertebrates. Construction activities would also disturb or eliminate reservoir substrates which are used by benthic macroinvertebrates and some fish species for protection and foraging.

The impacts of such habitat modification/elimination would probably be restricted to the immediate construction area and would be considered local, short-term, and of limited biological significance. Revegetation

of the disturbed area would be anticipated within a few years. Fish and macroinvertebrate repopulation would be anticipated within a few months to one year of the completion of construction.

The nature and extent of aquatic biological impacts anticipated to be associated with slurry pipeline system construction were generically discussed in Section 3.A.3, above, and are expected to be similar for the streams and rivers of South Dakota and Wyoming which would be crossed by the Oahe Alternative water supply pipeline.

The finescale dace, longnose sucker, northern redbelly dace, and sturgeon chub could be affected by pipeline construction and they are discussed in the Threatened and Endangered Species Technical Report.

Operation, Maintenance, and Abandonment

The water supply intake would draw approximately 20,000 acre feet/year (approximately 28 cfs) from the Oahe Reservoir. Depending on the intake design and location it may entrain (draw into the intake) eggs and newly hatched fishes including yellow perch, buffalofishes, shiners, and assorted invertebrates, and it may impinge (draw against the intake structure) adult and juvenile fishes. An estimation of the significance of such impacts will be provided when design and location criteria are available. Generally, however, an intake pumping such a small volume of water, located below the water surface and away from a shoreline area, and pumping at a velocity of less than 0.5 ft/second would be expected to have limited biological impact (Nelson and Beckman 1979). Furthermore, Nelson and Beckman (1979) have identified critical fish spawning areas in the Oahe Reservoir and there appear to be none in close proximity to the proposed intake location.

The only potentially significant impacts anticipated to be associated with the operation of the Oahe Reservoir pipeline (exclusive of the intake) would be the result of a pipeline rupture into a perennial river

or into a temporary stream with an established biota. The effects of such a rupture on fish and invertebrate populations have been generically discussed in Section 3.A.2, above.

The finescale dace, longnose sucker, northern redbelly dace, and sturgeon chub could be affected by a pipeline rupture in the same way and to the same extent as other fishes, as described in Section 3.A.2, above. These fishes are discussed in the Threatened and Endangered Species Technical Report.

### 3.G.2 PUMP STATIONS

Construction

The Oahe Alternative pump stations would all be constructed one or more miles away from streams which would be crossed by the pipeline. It is anticipated, therefore, that construction related impacts (identified in Section 3.A.1, above) on most of these streams would be intermittent (associated with rainstorm runoff), localized, and biologically insignificant. The construction sites would not be adjacent to stream channels and four of the eight pump stations would be in intermittent drainages. Details regarding construction impacts on intermittent stream biota in this region are presented in Section 3.A.1, above.

Of the four pump stations which would be in perennial stream drainages only one at MP 196 would be located in a biologically sensitive area; the Redwater and Sand Creek drainages of the "Black Hills" region. These streams sustain populations of threatened fishes and trout, respectively. The construction effects on these fishes, however, would be anticipated to be intermittent (associated with rainstorms), localized, and biologically insignificant since they would be expected to leave the affected area during rainstorms but would probably return as flood waters subside in a few days.

It would be anticipated that flood waters would dilute and carry the construction site pollutants downstream to larger bodies of water which could more readily assimilate them.

If construction site silt were deposited in the affected streams a shift in invertebrate community structure favoring silt-tolerant species would be expected. This would be unlikely, however, since these streams already carry high silt loads and flush themselves of excess silt in these sensitive areas.

Additional information regarding the finescale dace, longnose sucker, northern redbelly dace, and sturgeon chub is reported in the Threatened and Endangered Species Technical Report.

Operation, Maintenance, and Abandonment

No significant aquatic biological impacts would be anticipated as a result of routine operation, maintenance, and abandonment procedures since the station would require only a small workforce for operation and maintenance.

No significant impacts would be anticipated as a result of abandonment procedures since the above ground structures would be removed and the disturbed land revegetated in a short period of time.

## 3.H SLURRY PIPELINE WATER DISCHARGE ALTERNATIVE

### 3.H.1 WATER TREATMENT FACILITIES

Construction

It is anticipated that construction of the water treatment facilities at the power plant and/or dewatering plant sites would have no additional detectable aquatic biological impact in excess of those identified in

Section 3.A.4, above. The potentially affected areas would already be affected as described in Section 3.A.4.

Operation, Maintenance, and Abandonment

No significant aquatic biological impact would be anticipated to be associated with routine operation, maintenance, and abandonment procedures since no physical or chemical river effects are anticipated.

### 3.H.2 DISCHARGE FACILITIES

Construction

No significant aquatic biological impacts would be anticipated for the reasons cited in Section 3.H.1, above.

Operation, Maintenance, and Abandonment

No significant aquatic biological impacts would be anticipated since the water treatment facility effluent would meet NPDES water quality standards.

The fat pocketbook mussel is discussed in the Threatened and Endangered Species Technical Report.

## 3.I COMBINED WELL FIELD ALTERNATIVE WATER SUPPLY SYSTEM

Operation of the Niobrara and Crook County well fields would cause surface flow reductions in some Black Hills streams. These effects are described on an individual stream basis in Sections 3.A and 3.F.

## 3.J TREATED WASTEWATER ALTERNATIVE WATER SUPPLY SYSTEM

Since all treatment facilities presently discharge into streams, removal of water for the wastwater water supply system would cause reduced flows in the receiving waters. In fact, the Rapid City treatment facility contributes a significant portion of the stream flow below Pactola Reservoir. On 18 September 1979 flow above the sewage discharge in Rapid Creek was 5.5 cfs while below the outfall 18.4 cfs was reported (Strub 1981). Using these figures, removal of the 12.4 cfs for the wastewater alternative would reduce flows below the outfall by 67 percent. Rapid Creek, below Rapid City, was rated as a substantial fishery resource (Class III waters) by the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks (1978). Glover (1979) suggested 15 cfs as the minimum flow recommendation for maintenance of fish and wildlife resources in Rapid Creek below Pactola Reservoir, however, the stretch for which the recommendation was made ends above the sewage outfall. Consequently, no minimum flow recommendations exist downstream of the outfall. The proposed wastewater removal would severely reduce flows in Rapid Creek below the outfall, particularly during dryer months. Such large reductions would cause significant impacts to aquatic resources in Rapid Creek downstream of the sewage outfall. Impacts which result from reduced stream flows in Black Hills streams were previously described in Section 3.4.

Not all effects from removal of the wastewater discharge are expected to be adverse; significant, although localized, improvements in receiving water quality could result. Although specific data are lacking, a decrease in chlorine, ammonia and water temperature could be reasonably expected for some distance below the outfall. Such improvements may provide habitat for species previously unable to survive the adverse (toxic) effects of existing water quality.

The wastewater alternative would remove 1.3 cfs from the Belle Fourche River at the town of Belle Fourche, South Dakota. This stretch was rated as a high-priority fishery resource by the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks

(1978). Removal of 1.3 cfs from the Belle Fourche River would violate minimum stream flow recommendations (Glover 1979) for each month from September through March. During each of these months the recommended flows adequate to maintain existing fish and wildlife resources is 100 percent of the available dishcarge. According to Hanten and Talsma (1981), reductions in flows in the Belle Fourche River even as low as 1.3 cfs would cause significant, adverse impact to existing aquatic resources. The impacts would be the same as those described for the Belle Fourche River in Section 3.A from well field related drawdowns.

Specific data are lacking from Whitewood and Box Elder Creeks. However, the large reductions in flow below the sewage outfalls (9.3 and 2.6 cfs, respectively) suggests potentially significant adverse impacts to aquatic biota. Beneficial water quality could be reasonably expected in these streams. These impacts would probably be similar to those described for Rapid Creek above.

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# APPENDIX

Table A1. STREAMS AND RIVERS IN WYOMING AND SOUTH DAKOTA WHICH COULD BE SUBJECTED TO SURFACE FLOW REDUCTIONS RESULTING FROM DRAWDOWN OF THE MADISON FORMATION. [1]

| STREAM | RATING[2] |
|---|---|
| Belle Fourche River | Class III |
| Beaver Creek | Class III |
| Blacktail Creek | Class IV |
| Lame Jones Creek | Class IV |
| Oak Creek | Class IV |
| Miller Creek | Class III |
| Redwater Creek | Class III |
| Rocky Ford Creek | Class III |
| Unnamed Tributary to Rocky Ford Creek | Class IV |
| South Redwater Creek | Class IV |
| Sundance Creek | Class IV |
| Sand Creek | Class I, II and III |
| Redwater Creek | Class II |
| Spearfish Creek | Class I, II and IV |
| Unnamed Tributary to Spearfish Creek | Class II |
| Crow Creek | Class II |
| Chicken Creek | Class II |
| Unnamed Tributary to Redwater River | Class II |
| Stockade Beaver Creek | Class III |
| Whitewood Creek | Class IV |
| Cheyenne River | Class III |
| Cottonwood Springs Creek | Class III |
| False Bottom Creek | Class IV |
| Hay Creek | Class IV |
| Fall River | Class III |

Table A1. (continued)

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1-although many more intermittent streams occur in the area which would be affected by surface water flow reductions, only streams and rivers which were rated by the Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks (1978) and the Fish and Wildlife Service and the Wyoming Game and Fish Department (1978) are listed here. No streams in Nebraska would be affected by surface water flow reductions.

2-Class I indicates the highest-valued fishery resource; Class II indicates a high-priority fishery resource; Class III indicates a moderate fishery resource; and Class IV indicates a limited fishery resource.

Table A2. ESTIMATED STREAM FLOW REDUCTIONS WHICH COULD RESULT FROM IMPLEMENTATION OF PLAN 2 (NIOBRARA AND GILLETTE WELL FIELDS) IN THE BELLE FOURCHE RIVER AT THE WYOMING-SOUTH DAKOTA STATE LINE AND IN SPEARFISH CREEK.[1]

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Belle Fourche River (Plan 2 would result in a 1 cfs decrease in river flow at the Wyoming-South Dakota state line). | | | | |
| January | 2.1 | 2.1 | 1.1 | 47.6 |
| February | 1.6 | 1.6 | 0.6 | 62.5 |
| March | 5.6 | 5.6 | 4.6 | 17.8 |
| April | 23.0 | 23.0 | 22.0 | 4.3 |
| May | 12.0 | 12.0 | 11.0 | 8.3 |
| June | 14.7 | 14.7 | 13.7 | 6.8 |
| July | 5.2 | 5.2 | 4.2 | 19.2 |
| August | 1.4 | 1.4 | 0.4 | 71.4 |
| September | 2.8 | 2.8 | 1.8 | 35.7 |
| October | 2.8 | 2.8 | 1.8 | 35.7 |
| November | 3.9 | 3.9 | 2.9 | 25.6 |
| December | 2.2 | 2.2 | 1.2 | 45.4 |

Table A2. (continued)

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Spearfish Creek (Plan 2 would result in a 1 cfs decrease in stream flow in the entire drainage basin). | | | | |
| January | 24.2 | 15.0 | 23.2 | 0 |
| February | 26.8 | 15.0 | 25.8 | 0 |
| March | 27.2 | 15.0 | 26.2 | 0 |
| April | 33.5 | 33.5 | 32.5 | 3.0 |
| May | 36.2 | 36.2 | 35.2 | 2.8 |
| June | 35.9 | 35.9 | 34.9 | 2.8 |
| July | 29.5 | 29.5 | 28.5 | 3.5 |
| August | 27.4 | 27.4 | 26.4 | 3.7 |
| September | 26.8 | 26.8 | 25.0 | 4.0 |
| October | 28.0 | 15.0 | 27.0 | 0 |
| November | 27.9 | 15.0 | 26.9 | 0 |
| December | 24.3 | 15.0 | 23.3 | 0 |

1-data from Glover (1979)

Table A3. ESTIMATED STREAM FLOW REDUCTIONS WHICH COULD RESULT FROM IMPLEMENTATION OF PLAN 3 (CROOK COUNTY WELL FIELD) IN THE BELLE FOURCHE RIVER AT THE WYOMING-SOUTH DAKOTA STATE LINE AND IN SPEARFISH CREEK.[1]

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Belle Fourche (Plan 3 would result in a 4 cfs decrease in river flow at the Wyoming-South Dakota state line. | | | | |
| January | 2.1 | 2.1 | 0 | 100.0 |
| February | 1.6 | 1.6 | 0 | 100.0 |
| March | 5.6 | 5.6 | 1.4 | 71.4 |
| April | 23.0 | 23.0 | 19.0 | 17.3 |
| May | 12.0 | 12.0 | 8.0 | 33.3 |
| June | 14.7 | 14.7 | 10.4 | 27.2 |
| July | 5.2 | 5.2 | 1.2 | 76.9 |
| August | 1.4 | 1.4 | 0 | 100.0 |
| September | 2.8 | 2.8 | 0 | 100.0 |
| October | 2.8 | 2.8 | 0 | 100.0 |
| November | 3.9 | 3.9 | 0 | 100.0 |
| December | 2.2 | 2.2 | 0 | 100.0 |

Table A3. (continued)

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Spearfish Creek (Plan 3 would result in a 1 cfs decrease in stream flow in the entire drainage basin). | | | | |
| January | 24.2 | 15.0 | 23.2 | 0 |
| February | 26.8 | 15.0 | 25.8 | 0 |
| March | 27.2 | 15.0 | 26.2 | 0 |
| April | 33.5 | 33.5 | 32.5 | 3.0 |
| May | 36.2 | 36.2 | 35.2 | 2.8 |
| June | 35.9 | 35.9 | 34.9 | 2.8 |
| July | 29.5 | 29.5 | 28.5 | 3.5 |
| August | 27.4 | 27.4 | 26.4 | 3.7 |
| September | 26.8 | 26.8 | 25.0 | 4.0 |
| October | 28.0 | 15.0 | 27.0 | 0 |
| November | 27.9 | 15.0 | 26.9 | 0 |
| December | 24.3 | 15.0 | 23.3 | 0 |

1-data from Glover (1979)

Table A4. ESTIMATED STREAM FLOW REDUCTIONS WHICH COULD RESULT FROM IMPLEMENTATION OF PLAN 4 (CROOK COUNTY AND GILLETTE WELL FIELDS) IN THE BELLE FOURCHE RIVER AT THE WYOMING-SOUTH DAKOTA STATE LINE AND IN SPEARFISH CREEK.[1]

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Belle Fourche River (Plan 4 would result in a 4 cfs decrease in river flow at the Wyoming-South Dakota state line. | | | | |
| January | 2.1 | 2.1 | 0 | 100.0 |
| February | 1.6 | 1.6 | 0 | 100.0 |
| March | 5.6 | 5.6 | 1.4 | 71.4 |
| April | 23.0 | 23.0 | 19.0 | 17.3 |
| May | 12.0 | 12.0 | 8.0 | 33.3 |
| June | 14.7 | 14.7 | 10.4 | 27.2 |
| July | 5.2 | 5.2 | 1.2 | 76.9 |
| August | 1.4 | 1.4 | 0 | 100.0 |
| September | 2.8 | 2.8 | 0 | 100.0 |
| October | 2.8 | 2.8 | 0 | 100.0 |
| November | 3.9 | 3.9 | 0 | 100.0 |
| December | 2.2 | 2.2 | 0 | 100.0 |

Table A4. (continued)

| MONTH | 7-DAY-10-YEAR LOW FLOW (cfs)[1] | RECOMMENDED MINIMUM FLOW (cfs)[1] | MEAN MONTHLY FLOW AFTER IMPLEMENTATION OF PLAN (cfs) | PERCENTAGE OF FLOW LOST WITH PLAN (cfs) |
|---|---|---|---|---|
| Spearfish Creek (Plan 4 would result in a 1 cfs decrease in stream flow in the entire basin). | | | | |
| January | 24.2 | 15.0 | 23.2 | 0 |
| February | 26.8 | 15.0 | 25.8 | 0 |
| March | 27.2 | 15.0 | 26.2 | 0 |
| April | 33.5 | 33.5 | 32.5 | 3.0 |
| May | 36.2 | 36.2 | 35.2 | 2.8 |
| June | 35.9 | 35.9 | 34.9 | 2.8 |
| July | 29.5 | 29.5 | 28.5 | 3.5 |
| August | 27.4 | 27.4 | 26.4 | 3.7 |
| September | 26.8 | 26.8 | 25.0 | 4.0 |
| October | 28.0 | 15.0 | 27.0 | 0 |
| November | 27.9 | 15.0 | 26.9 | 0 |
| December | 24.3 | 15.0 | 23.3 | 0 |

1-data from Glover (1979)

Table A5. MEAN MONTHLY FLOWS AND RECOMMENDED MINIMUM FLOWS DURING 7-DAY-10-YEAR LOW FLOW PERIODS IN THE CHEYENNE RIVER AT PLAINVIEW, SOUTH DAKOTA AND AT THE CONFLUENCE OF CHERRY CREEK.[1]

| | AT PLAINVIEW, SOUTH DAKOTA | | AT THE CONFLUENCE OF CHERRY CREEK | |
|---|---|---|---|---|
| | 7-DAY-10-YEAR LOW FLOW (cfs) | RECOMMENED MINIMUM FLOW (cfs) | 7-DAY-10-YEAR LOW FLOW (cfs) | RECOMMENDED MINIMUM FLOW (cfs) |
| January | 13.3 | 13.3 | 29.8 | 29.8 |
| February | 35.5 | 35.5 | 28.2 | 28.2 |
| March | 37.7 | 37.7 | 46.4 | 46.4 |
| April | 107.2 | 107.2 | 126.3 | 126.3 |
| May | 61.9 | 61.9 | 83.3 | 83.3 |
| June | 90.4 | 90.4 | 122.3 | 122.3 |
| July | 94.0 | 94.0 | 140.7 | 140.7 |
| August | No Data Available | 100% | 64.3 | 64.3 |
| September | No Data Available | 100% | No Data Available | 100% |

Table A5.(continued)

| | AT PLAINVIEW, SOUTH DAKOTA | | AT THE CONFLUENCE OF CHERRY CREEK | |
|---|---|---|---|---|
| | 7-DAY-10-YEAR LOW FLOW (cfs) | RECOMMENED MINIMUM FLOW (cfs) | 7-DAY-10-YEAR LOW FLOW (cfs) | RECOMMENDED MINIMUM FLOW (cfs) |
| October | 77.4 | 77.4 | 71.5 | 71.5 |
| November | 64.6 | 64.6 | 67.6 | 67.6 |
| December | 27.8 | 27.8 | No Data Available | 100% |

1-data from Glover (1979).

Table A6. CHANGES IN GROUND-WATER DISCHARGE RATES TO THE MAJOR STREAMS AND SPRINGS IN THE BLACK HILLS REGION AS A RESULT OF WITHDRAWALS FROM THE MADISON AQUIFER DURING THE PERIOD 1985 to 2035[a]

| Approximate Location | Column A: Current Use Only, 1985-2035 Time Period | Calculated Change in Discharge Rate (cfs): Plan 1: Niobrara W.F. Only | | Plan 2: Niobrara W.F. Plus Gillette W.F. | | Plan 3: Crook W.F. Only | | Plan 4: Crook W.F. Plus Gillette W.F. | |
|---|---|---|---|---|---|---|---|---|---|
| | | ETSI Only | ETSI Plus Col. A | ETSI Only | ETSI Plus Col. A | ETSI Only | ETSI Plus Col. A | ETSI Only | ETSI Plus Col. A |
| Little Missouri River at the Montana-Wyoming State Line | - | - | - | - | - | 1 | 1 | 1 | 1 |
| Belle Fourche River (Keyhole Reservoir to Wyoming-South Dakota State Line | - | - | - | 1 | 1 | 4 | 4 | 4 | 4 |
| Sand Creek (entire drainage basin) | - | - | - | 2 | 2 | 3 | 4 | 4 | 4 |
| Crow Creek Springs, SD | - | - | - | 1 | 1 | 2 | 2 | 2 | 2 |
| Spearfish Creek (entire drainage basin) | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 |
| Stockade-Beaver Creek (entire drainage basin) | - | - | - | - | - | - | - | 1 | 1 |
| Rapid Creek (entire drainage basin west of the Precambrian core of the Black Hills uplift) | - | - | - | - | - | - | - | - | - |
| Cheyenne River (upstream of Angostura Reservoir) | - | 1 | 1 | 1 | 1 | - | - | - | - |
| Cascade Springs, SD | - | 4 | 4 | 3 | 3 | - | - | - | - |
| Hot Springs, SD | - | 2 | 2 | 1 | 1 | - | - | - | - |

Note: Numbers in the columns above are rounded to the nearest whole number and may not add exactly. W.F. = well field.

[a]Calculated reductions in stream flow and spring flow.

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